JUNE 1956

THE WELDING JOURNAL

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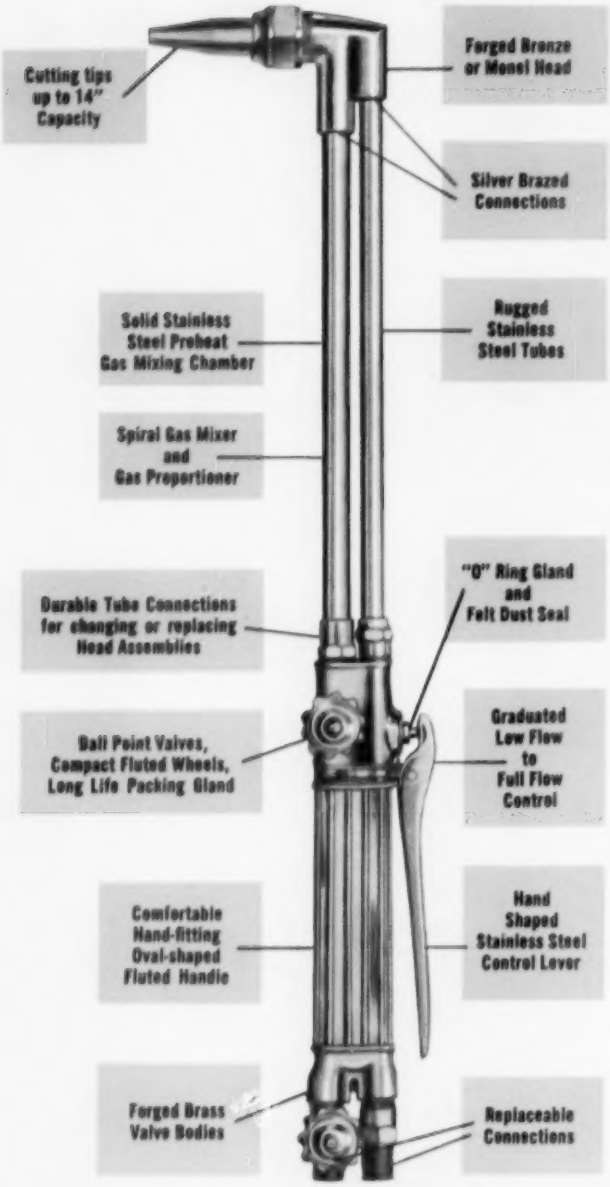
OFFICIAL PUBLICATION OF THE AMERICAN WELDING SOCIETY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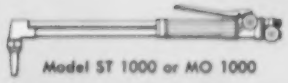
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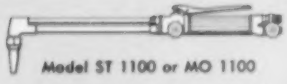
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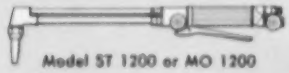
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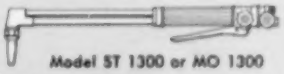
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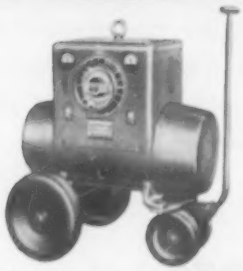

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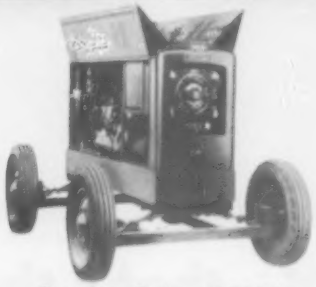

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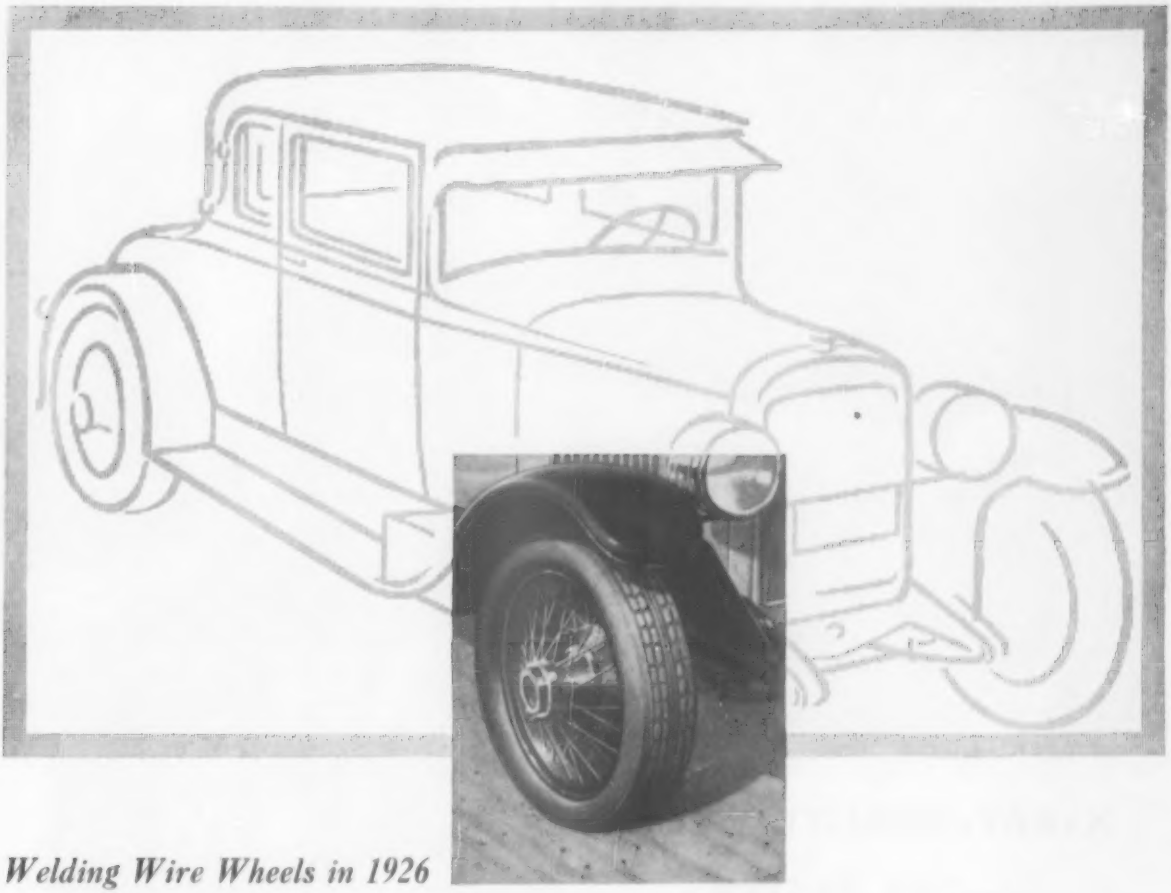

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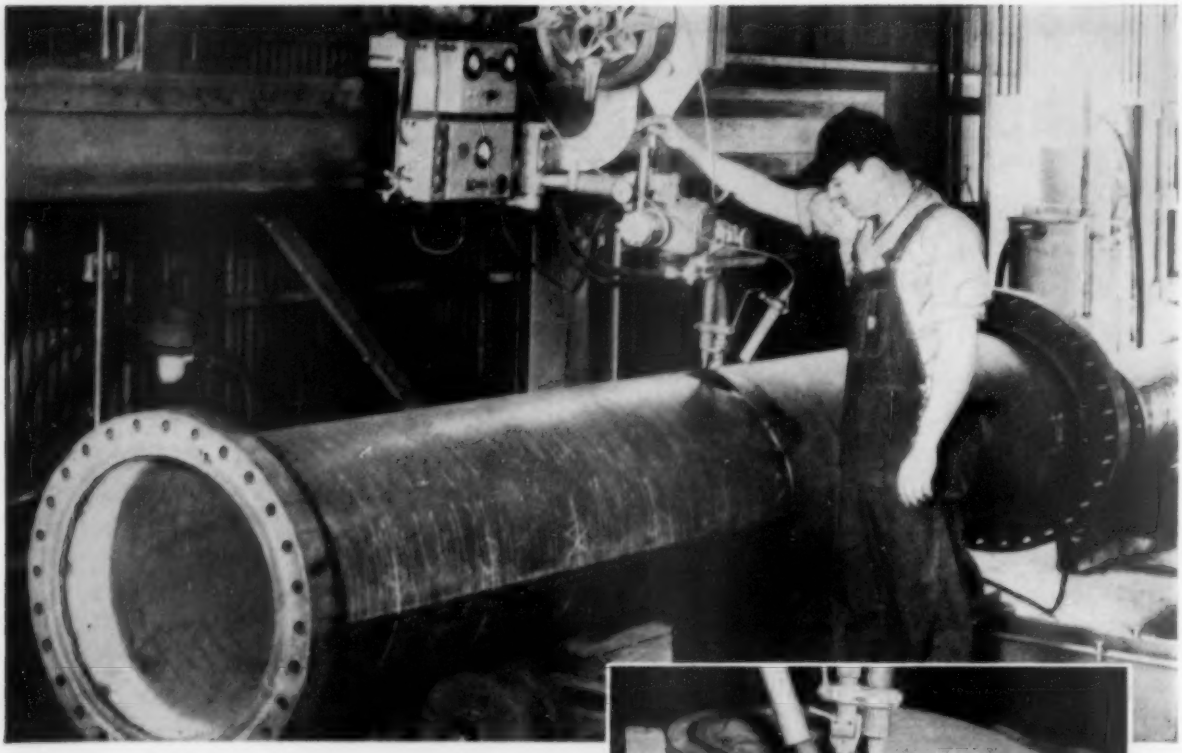

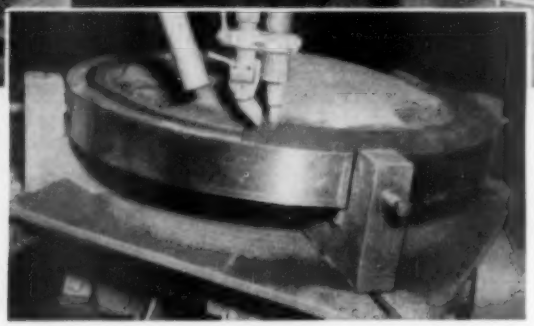

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Knocked down—but not out

thanks to easy repair with Ni-Rod "55"

A bumper is a lamppost's worst enemy.

In the last ten years motorists have knocked down between 50 and 75 cast iron posts at Forest Hills Gardens, N. Y. — sometimes the same one several times.

New lampposts run up quite a bill at about $500 each. So the company calls in General Welding Service, Elmhurst, N. Y., to weld the posts back up. Often Forest Hills Gardens Corporation — responsible for maintenance — can't catch the guilty party.

Repairs must be fast. Breaks are usually a foot or two above the ground. Jagged metal edges and bare live wires could be dangerous to the neighborhood children.

Repairs *are* fast with easy-to-handle NI-ROD "55"* electrodes. Usually General Welding has a weldor on the spot within thirty minutes . . . and he completes the repair within two or three hours.

The average cost is under $50. The saving to the company — thousands of dollars over the years!

Where to use Ni-Rod and Ni-Rod "55" electrodes

General Welding repaired this bumper crop of lampposts with NI-ROD* electrodes until 1951 when the NI-ROD "55" electrode was introduced.

Though there is no hard and fast rule, weldors usually choose NI-ROD electrodes as their general purpose electrode for welding cast iron . . . particularly where thin sections are involved or machinability is important. They prefer NI-ROD "55" electrodes for welding heavy sections, high phosphorus irons, ductile iron, Ni-Resist* high nickel alloy cast iron, high-strength cast irons, or for joining these irons to other metals.

But here's proof that *both* electrodes give sound, strong, ductile welds. Of all the lampposts that have been knocked down again and again, *not one* has broken at the weld.

Send for Inco's new booklet, "A Handy Guide to Welding Cast Irons." Gives tips on weld preparation, technique, getting maximum machinability . . . contains illustrated stories of successful welding.

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A SERVICE ORGANIZATION

As incoming President of the AMERICAN WELDING SOCIETY, I wish to express to its 11,000 members the deep honor and responsibility that I feel. I assure them that I will do all in my power to direct the affairs of the SOCIETY in a manner bringing credit to it and to our profession.

Many problems will face us during the coming year. Only a few can be mentioned here.

The decision to "go out on our own," by consolidating our national meetings and our all-welding exposition into a single annual convention, is unquestionably one of the best moves we have made to date. Geographically, it gives us a much needed flexibility in the choice of convention sites. Welding, an always lusty youth, has now come of age.

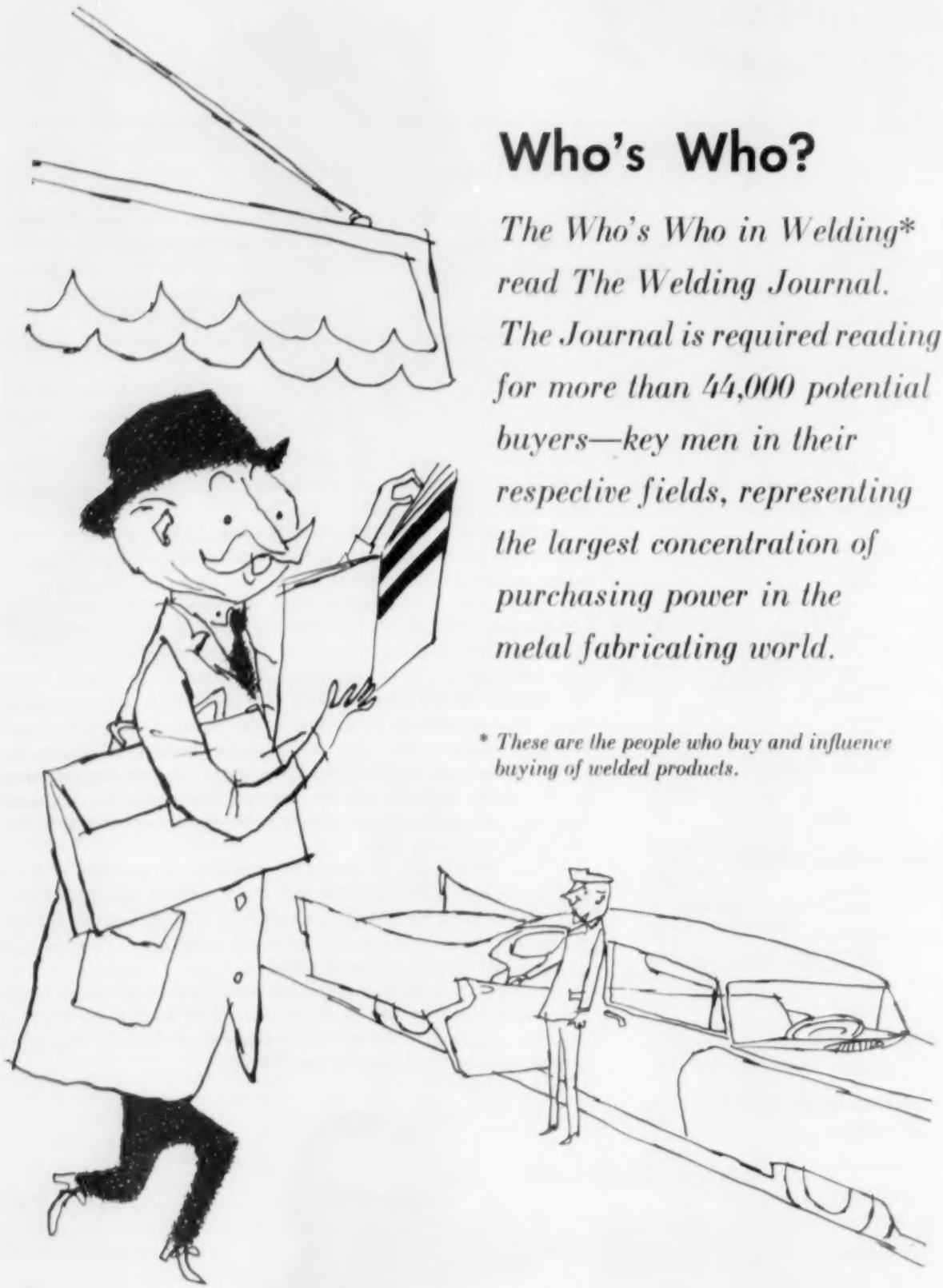
The problem of headquarters housing, how to get more room, and how to provide urgently needed facilities for greater efficiency, is one requiring early correction.

There are other questions that will also demand attention—for instance, the part that the SOCIETY should play in the knotty problem of certification of welders—but there is one point which, in my estimation, is of paramount importance. We must never lose sight of the fact that our SOCIETY is primarily a *service* organization. Our services go to groups whose interests are, sometimes, widely divergent. We must be of ever expanding service to the welder in the shop, to the aspiring student, to the welding engineer, to the design engineer, and to industrial management. We must help and urge engineering schools to recognize welding as a distinct and important field.

Yes, AWS is truly a *service* organization. It provides a direct and ever existing line for communication, contact and interchange of ideas between the SOCIETY's members and its section officers, its district directors and its board of directors. This path is straight and short in either direction.

As we—the members of this big SOCIETY of ours—move in our chosen direction, we will be doing more than serving our SOCIETY or even ourselves. We will be making a profoundly important contribution to the welfare of our Nation.

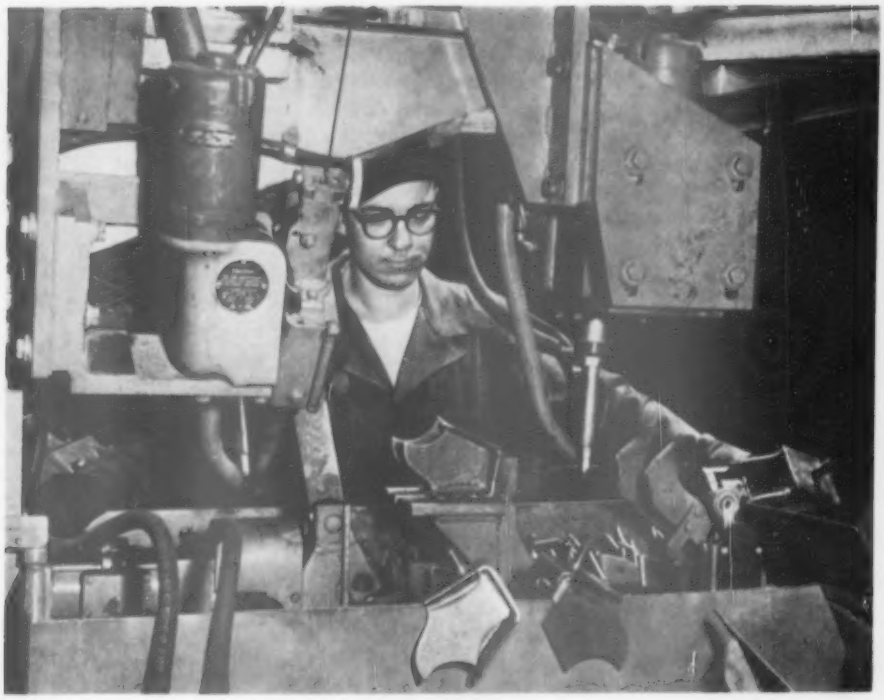
John J. Chyle
PRESIDENT
AMERICAN WELDING SOCIETY



Who's Who?

The Who's Who in Welding read The Welding Journal. The Journal is required reading for more than 44,000 potential buyers—key men in their respective fields, representing the largest concentration of purchasing power in the metal fabricating world.*

* *These are the people who buy and influence buying of welded products.*



Operator making short, high-speed submerged-arc welds in joining two stampings to form automotive shock-absorber brackets

A SELECTION GUIDE FOR METHODS OF SUBMERGED-ARC WELDING

BY ROBERT A. WILSON

Author reviews reasons for choice of different type of automatic submerged-arc welding and describes the chief advantages of the different processes and equipment now available which have been responsible for its success

Process Selection

Before attempting to select a particular method of submerged-arc welding for a given application, the first decision must be: is the job adapted to automatic welding, or should it be done with semiautomatic or hand welding?

Hand welding should be carefully considered for non-repetitive or low-production jobs, for small welds or odd shapes that would require extremely complicated fixturing. As can be seen from Fig. 1, the deposition rates of the fastest hand electrodes may be higher than the automatic processes at currents *under* 400 amp.

Semiautomatic welding (Fig. 2) may be a more practical answer for medium production runs where there is considerable footage of welding, either in long welds or repetitive short welds. It is used on applications where more penetration is required than can be obtained through hand welding. Manual guiding and simple low-cost fixturing permit its use on irregular shapes and on work that is too large to be positioned under an

Robert A. Wilson is Director of Application Engineering, Lincoln Electric Co., Cleveland, Ohio.

Paper presented at 1955 AWS National Fall Meeting in Philadelphia, Pa., October 17-21.

automatic head, such as heavy presses, dam gates, etc.

Fully automatic welding. Where the volume of welding warrants fixturing for the fully automatic operation, and where fit-up and shape of parts are satisfactory, it is possible to take advantage of high-speed, high-quality fully automatic, reliable welding at a great reduction in labor cost. Factors that must be considered in selection of the best process are shown in Fig. 3.

Type of Current

Once automatic welding is decided upon, the next logical step is to choose between a-c or d-c welding.

AC Welding

The choice of ac usually hinges upon the presence of *arc blow* (Fig. 4). Ac minimizes arc blow, although it does not eliminate it. Magnetic influence on the arc may be due to the shape of the workpiece and path of the ground circuit or due to the proximity of another arc (as in tandem-arc welding). The effect of arc blow is increased at high currents; therefore, ac may be worth considering for very large welds, especially when short in length.

Since, however, dc usually produces better bead shape and uniformity on *high-speed* welds, the general approach should be to try dc and to make certain that fixtures are properly constructed to eliminate unnecessary arc blow. Arc-length control has always been a little more difficult and less sensitive with ac

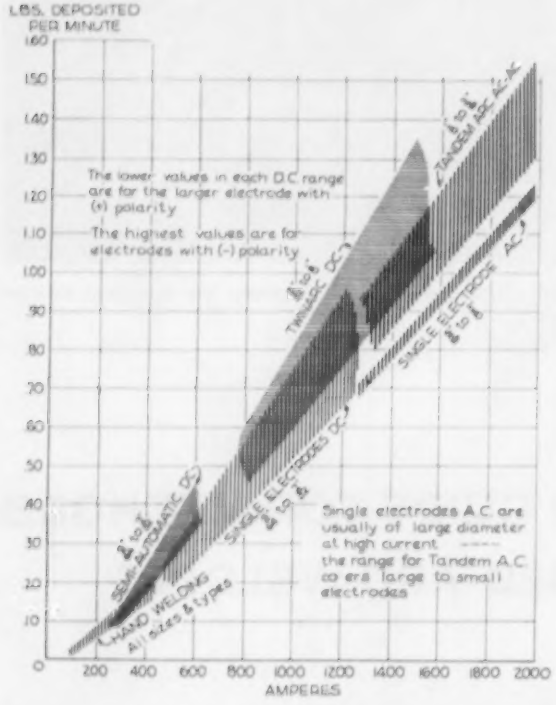


Fig. 1 Approximate deposition rate of submerged-arc processes on mild steel

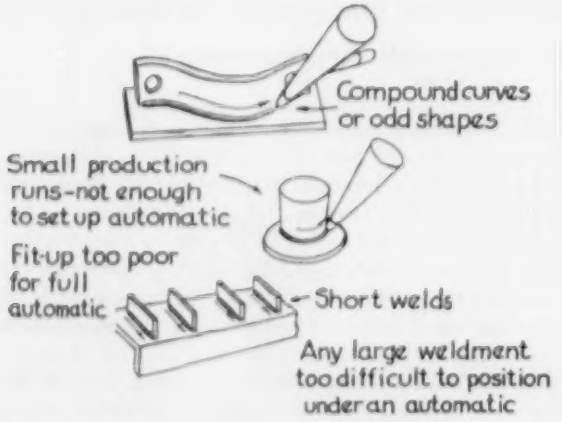

Compound curves or odd shapes
Small production runs-not enough to set up automatic
Fit-up too poor for full automatic
Short welds
Any large weldment too difficult to position under an automatic

Fig. 2 When to use semiautomatic equipment

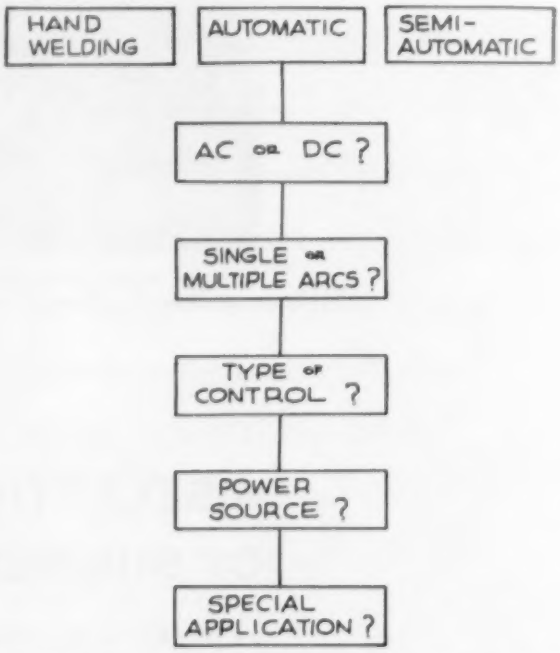


Fig. 3 Factors to be considered in choosing proper submerged-arc process

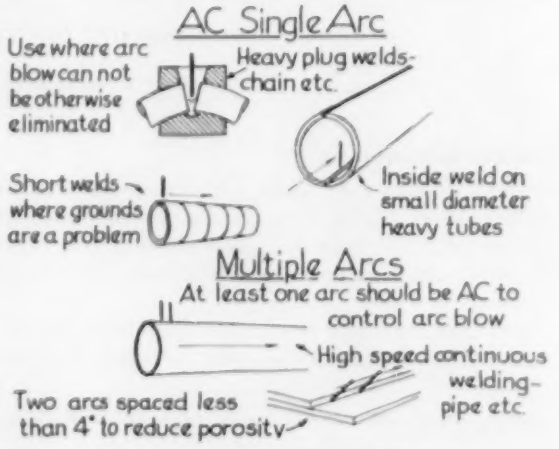

AC Single Arc
Use where arc blow can not be otherwise eliminated
Heavy plug welds-chain etc.
Inside weld on small diameter heavy tubes
Short welds where grounds are a problem
Multiple Arcs
At least one arc should be AC to control arc blow
High speed continuous welding-pipe etc.
Two arcs spaced less than 4" to reduce porosity

Fig. 4 When to use a-c single arc and multiple arcs

than with dc. The control of the arc in a-c welding has been improved by the recent development which uses a control exciter in the arc circuit replacing the resistance formerly used to regulate the arc length. This tends to eliminate the variations in electrode feed due to changes in load on the feed motor.

Ac is usually preferred for *multiple-arc* welding. Two arcs in close proximity (say, less than 4 in. apart) are affected by each other's magnetic field. Two like polarity d-c arcs flare together while unlike polarities flare apart. If one a-c and one d-c arc are used, this tendency is reduced. When two a-c arcs are used with Scott-connected transformers, this flare of the arcs can be controlled and directed so that arc blow and lagging of the arc at high speeds can be counteracted.

DC Welding

These general statements can be made of single-arc, d-c welding in comparison to a-c welding: d-c welding is more versatile than ac with more control over bead shape, penetration and speed; d-c arc starting is much better; d-c arc length can be maintained more accurately (Fig. 5).

(1) Dc is preferred where fast and accurate arc striking is important. (High production on small parts, or for skip welds, etc.) (Fig. 6).

(2) Dc is preferred where close arc control is needed as in high-speed, sheet-metal welding.

(3) Dc is preferred where difficult contours are to be followed at maximum speed (Fig. 7).

(4) Bead shape is easiest controlled with dc (+) because of better wash-in and less molten metal. Highest deposition rates are obtained by dc (−). Ac lies somewhere between these two d-c polarities (close to dc (+) in deposition).

(5) Dc (+) gives maximum penetration; dc (−) gives minimum penetration; ac is in between.

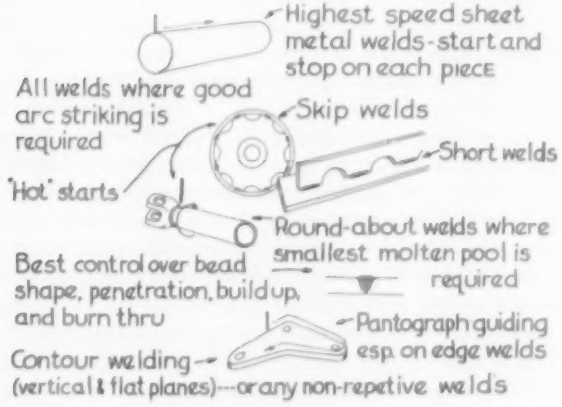

Highest speed sheet metal welds-start and stop on each piece
All welds where good arc striking is required
Skip welds
Short welds
"Hot" starts
Round-about welds where smallest molten pool is required
Best control over bead shape, penetration, build up, and burn thru
Pantograph guiding esp. on edge welds
Contour welding (vertical & flat planes)---or any non-repetive welds

Fig. 5 When to use single arc d-c welding

Fig. 6 High-speed, short welds made on automotive generator mounting bracket

Multiple Arcs

The use of *multiple arcs* can increase melt-off rates and directs the arc blow with a corresponding increase in speeds. The use of two arcs also slows the rate of freezing and reduces the trapping of gas (porosity) in the weld The use of Scott-connected transformers on two a-c arcs allows considerable control over the direction of arc blow at each arc. The amount of blow at the arcs is usually reduced when a-c and d-c arcs are combined, but there is less control over the direction

Fig. 7 Welds on this tractor draw bar beam follow compound curves

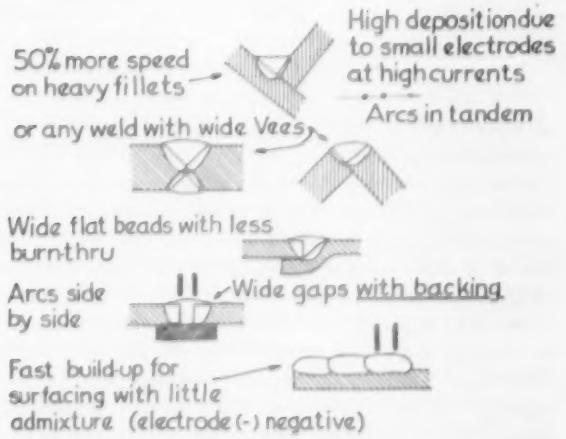

50% more speed on heavy fillets
High deposition due to small electrodes at high currents
Arcs in tandem
or any weld with wide Vees
Wide flat beads with less burn-thru
Arcs side by side
Wide gaps with backing
Fast build-up for surfacing with little admixture (electrode (-) negative)

Fig. 8 When to use twin-arc d-c welding

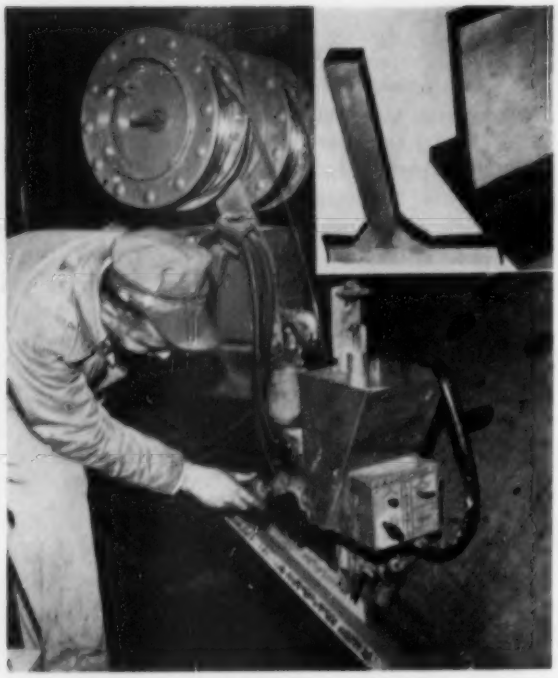


Fig. 9 Twin arc used for downhand fillet welding girder flange to web

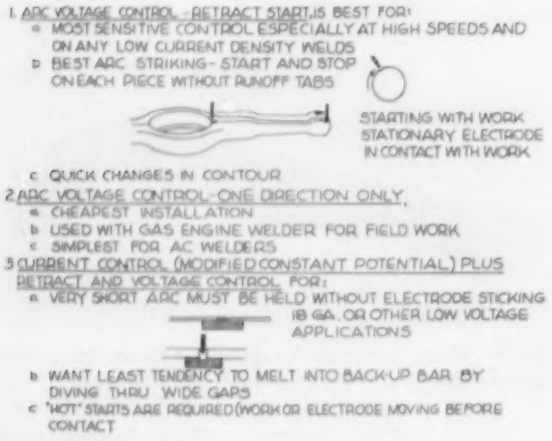

1. ARC VOLTAGE CONTROL - RETRACT START IS BEST FOR:
a MOST SENSITIVE CONTROL ESPECIALLY AT HIGH SPEEDS AND ON ANY LOW CURRENT DENSITY WELDS
b BEST ARC STRIKING - START AND STOP ON EACH PIECE WITHOUT RUNOFF TABS
STARTING WITH WORK STATIONARY ELECTRODE IN CONTACT WITH WORK
c QUICK CHANGES IN CONTOUR
2. ARC VOLTAGE CONTROL - ONE DIRECTION ONLY.
a CHEAPEST INSTALLATION
b USED WITH GAS ENGINE WELDER FOR FIELD WORK
c SIMPLEST FOR AC WELDERS
3. CURRENT CONTROL (MODIFIED CONSTANT POTENTIAL) PLUS RETRACT AND VOLTAGE CONTROL FOR:
a VERY SHORT ARC MUST BE HELD WITHOUT ELECTRODE STICKING 18 GA. OR OTHER LOW VOLTAGE APPLICATIONS
b WANT LEAST TENDENCY TO MELT INTO BACK-UP BAR BY DIVING THRU WIDE GAPS
c "HOT" STARTS ARE REQUIRED (WORK OR ELECTRODE MOVING BEFORE CONTACT

Fig. 10 Types of control

of blow. When three arcs are used, dc-ac-ac is the customary combination.

Twin arc—dc (two electrodes fed through same jaws from one power source, Fig. 8) utilizes a very high deposition rate to gain speed on welds where "fill-in" is a major consideration such as large *flat* position fillets (Fig. 9) and *wide* vee joints, etc. The two arcs "pull" together giving back blow at front arc and forward blow at trailing arc. This relationship cannot be varied. This is the simplest and cheapest form of multiple-arc welding. Twin-arc welding, where it can be applied, usually results in about a 50% speed increase over single arc.

Tandem arcs (two or more electrodes each with its own separately-controlled power source) have a speed advantage on both "fill-in" welds and square-edge butt welds. While tandem-arc welding is the ultimate in speed, the complications of setting the proper procedure on multiple separate arcs with all the possible variables of voltage, current, spacing, electrode size, etc., make this process suitable mainly for long runs of identical joints, such as, continuous pipe mills, railroad car welding, or very large welds, etc. On heavy plate, at least one arc is usually ac, while on light-gage welding, dc may be used in plants where input line voltage varies, since d-c motor generators are not affected by input voltage variations, which, in turn, can vary welding current. Two tandem arcs usually increase speeds up to 100% over single arc. Three arcs will add another 50% or so.

Type of Control

The method of arc-length control by voltage or current can have considerable bearing on the success of any application. Arc-length control has two functions. It should back up the electrode at the instant of arc striking to establish the arc without having the electrode "freeze" to the work. Once the arc is established, it should maintain the correct arc length even though there are sudden variations in the distance from the jaws to the work.

Arc striking is the more critical of the two requirements. Good arc striking requires the best arc-control system available, while almost any type of control may be adequate to maintain the proper arc length as long as no radical changes in contour are encountered (Fig. 10).

One method of *arc-voltage control* backs up the electrode to start. This is the best method for standing starts and low-current welding, especially at high speeds. This method regulates the speed of the electrode feed and can actually stop or reverse electrode feed if sudden changes in the contour of the joint require it. This method is recommended for any job where close control of bead shape is essential.

The second choice is *arc-voltage control* without the ability to back up. Arc-voltage control may be set up to govern arc length by controlling the feed in one direction only. This arrangement has the electrode feed

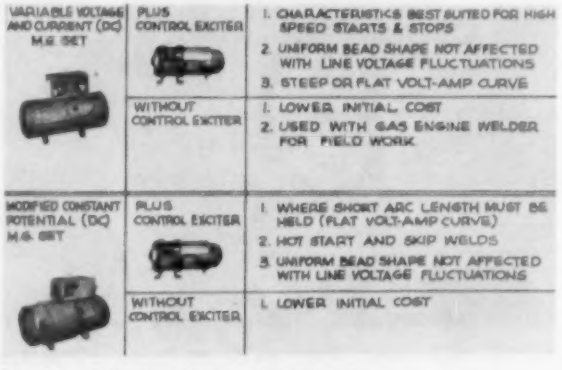

VARIABLE VOLTAGE AND CURRENT (DC) M-G SET
PLUS CONTROL EXCITER
1. CHARACTERISTICS BEST SUITED FOR HIGH SPEED STARTS & STOPS
2. UNIFORM BEAD SHAPE NOT AFFECTED WITH LINE VOLTAGE FLUCTUATIONS
3. STEEP OR FLAT VOLT-AMP CURVE
WITHOUT CONTROL EXCITER
1. LOWER INITIAL COST
2. USED WITH GAS ENGINE WELDER FOR FIELD WORK
MODIFIED CONSTANT POTENTIAL (DC) M-G SET
PLUS CONTROL EXCITER
1. WHERE SHORT ARC LENGTH MUST BE HELD (FLAT VOLT-AMP CURVE)
2. HOT START AND SKIP WELDS
3. UNIFORM BEAD SHAPE NOT AFFECTED WITH LINE VOLTAGE FLUCTUATIONS
WITHOUT CONTROL EXCITER
1. LOWER INITIAL COST

Fig. 11 Submerged-arc power sources

motor armature connected across the arc. This is satisfactory for high-current density welding and where repetitive starting is no problem. This is the simplest and cheapest method, but does not have the sensitivity required for some jobs.

Current control is a method that depends on high-, short-circuit current characteristics to keep the arc length constant. If the arc length becomes shorter than desired, the current increases infinitely to melt the electrode more rapidly and bring the arc length back to equilibrium. This method uses a constant-potential power source and may use constant wire feed speed; or to make it more sensitive, a modified constant potential can be used in conjunction with arc-voltage control. In order to get good starting, the electrode must be able to back up to establish the arc.

Power Sources

Whereas the choice of power sources for years has been between a d-c variable voltage generator or an a-c transformer, recently both constant-potential generators and d-c rectifiers have been used for special applications. More experience is needed, however, to establish precisely where these types of power sources are best suited.

The decision is complicated by the fact that, for a particular application, the best type of d-c power source for one make of automatic head may not necessarily be best for another make. Heads with poor voltage control may be improved if the application permits using a constant potential power source and a constant wire feed speed. On the other hand, a head designed to give full-voltage control with a variable-voltage power source will usually give better performance than with constant wire speed on any application with irregular contours or requiring fast, accurate arc striking. For this reason many applications, where constant-potential power is being used or considered, could probably be best accomplished with variable-voltage controlled heads and generators.

Another factor that must be considered in selecting power sources is the available power lines and their voltage regulation. Motor generator output does not vary with input voltage and, therefore, bead shapes and penetration are not influenced by input voltage variations. This is not true when rectifiers are used as a source of d-c power. This must also be considered in certain high-speed, tandem-arc welding applications where ac or rectifiers are not satisfactory because variation of input line voltage causes output current variations which change bead shape, penetration and burn-through.

Types of Power Sources

(1) *Variable-Voltage Generator Plus Control Exciter.* The variable voltage motor generator (Fig. 11) is the type most widely used for d-c welding. The finest and most sensitive control of arc length is achieved with this type generator using a control exciter that provides a voltage opposing the arc voltage. The difference between these two voltages controls the speed of the electrode feed motor, maintaining a constant arc length. This method also provides the best arc striking for standing starts on high-speed applications because it automatically backs up the electrode for the work, helping establish the arc without the use of reversing relays.

(2) *Variable-Voltage Generator Without Control Exciter.* In field work where gas-engine welders are used, no source of three-phase power may be available to operate the control exciter. Under these conditions, a variable-voltage generator can be used with the electrode feed motor (shunt motor preferred) with the armature across the arc. This is the most elementary form of good d-c arc-length control and, while the variable voltage control with control exciter is always a preferred method, the simple series control can be used on many applications if the current density on the electrode is fairly high.

A recent improvement over one-directional series control is the new "bias" type control which actually controls the wire feed in both directions. This control does not use a control exciter to retract the electrode but obtains a back-up voltage through a bias circuit from the 125-v field exciter to obtain arc-length control and arc striking very close to that obtained by the use of the control exciter.

For low-current applications the open-circuit voltage control can be set for a flat volt-ampere characteristic and practically all the benefits of constant potential generators can be duplicated.

(3) *Constant-Potential Generators.* A constant-potential generator is a flat compounded generator that holds voltage practically constant regardless of the current used. When straight constant potential is used, the wire-feed motor is usually set at a constant speed, the current being controlled by the speed of the electrode feed. The arc length is controlled by instantaneous *current* fluctuations rather than *voltage*. As the arc length is shortened for any reason, the current automatically and rapidly increases until the increased melt-off lengthens the arc back to the original length. On applications where a very short arc length must be held, this is an advantage since the tremendous increase in current as the arc length approaches a short circuit keeps the electrode from sticking. This is an advantage for very light-gage welding, such as 18-gage material, where the arc voltage may be as low as 22 v.

On heavier material (16 gage and up) there is no noticeable advantage to the principle of varying the current to maintain the arc length, and there are times when, at low-current densities, the transfer of metal in large drops is enough to cause large and unwanted variations in current which tend to make it difficult to get a uniform weld. Where high currents can be used on small electrodes, this type of control is sufficient and it will actually smooth out the operation of some heads that do not have inherently good arc control.

This type of generator is advantageous in making "hot" starts, full current being applied to the electrode before it touches the work. For "cold" starts where the electrode is in contact with the work before the current

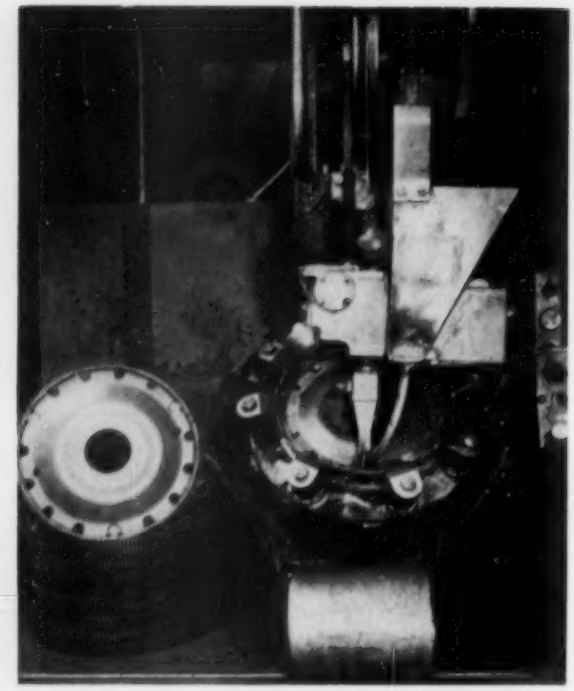


Fig. 12 Setup for "skip" welding starter ring gear to flywheel stamping

AC TRANSFORMER	1. AC WELDING 2. REDUCES ARC BLOW 3. CAN BE USED ON SINGLE PHASE
AC TRANSFORMER SCOTT CONNECTED	1. FOR TANDEM ARC WELDING BEST CONTROL OF ARC BLOW WITH SIMPLEST SETUP (90° PHASE ANGLE)
AC TRANSFORMER WITH DC RECTIFIER	1. DC OBTAINABLE WHERE SINGLE PHASE POWER EXISTS 2. LOW NOISE LEVEL 3. USED WHERE CUSTOMER DESIRES RECTIFIER AND INPUT LINE VOLTAGE IS CONSTANT

Fig. 13 Submerged-arc power sources

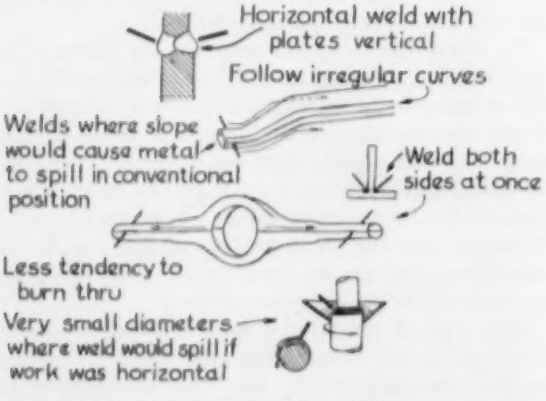

Horizontal weld with plates vertical
Follow irregular curves
Welds where slope would cause metal to spill in conventional position
Weld both sides at once
Less tendency to burn thru
Very small diameters where weld would spill if work was horizontal

Fig. 14 When to use three o'clock welding

is applied, the variable-voltage generator is usually preferred.

(4) *Modified Constant-Current Generator.* To obtain the benefits of constant-potential welding and still retain the better arc striking, it is possible to make a modified constant-potential generator with more drop in the volt-ampere curve. The voltage control can then be combined with the ability for the current to have greater variations to meet the need for suddenly increased or decreased melt-off in maintaining the proper arc length under rapidly changing conditions.

The ideal generator would have an arrangement allowing a choice of volt-ampere characteristics that could be determined by the application at hand. To do this, the control exciter would be used in conjunction with the modified constant-potential generator and voltage control would predominate over current control although both would be in effect. Constant wire feed would be used with this generator only for the very special applications where straight constant-potential welding is proved best.

When constant wire feed is used, it is best to use a separate control exciter as a variable-voltage power source to provide current for the wire feed motor armature, thus avoiding the inadvertent changes in speed caused by varying torque when a resistance control is used in the armature circuit.

The modified constant-potential generator used with a line contactor can be used to advantage in making "hot starts" and "skip" welds (Fig. 12) where arc striking while in motion is a requirement. The high surge of current prevents the electrode from sticking to the work by blasting the end off the electrode upon contact with the work. (When the work and electrode are *stationary*, this sudden surge of current tends to resistance weld the end of the electrode to the work and, for this reason, variable-voltage generators are generally used for standing starts.)

(5) *A-C Transformers.* A-c welding is done with a transformer-type welder (Fig. 13) and the only special features required are adequate continuous current capacity and some means of remote control of the current at the welding station. When using ac for tandem-arc welding, there are several possible ways in which the transformers can be connected to arrive at the tandem-arc currents from a three-phase input line: (*a*) closed Delta, (*b*) open Delta, (*c*) Scott connected. In order to control the bead shape at high speeds, it is necessary to have control over the magnetic arc blow that is present when two arcs are close together. Forward magnetic blow can be used to govern bead shape and to reduce undercutting. Some means of choosing the right balance between back blow and forward blow must be available. Control of the arc blow is governed by the phase sequence and phase angle of the currents of the two arcs. The simplest way to connect two a-c welders for tandem-arc welding is with the Scott connection (using the other connections requires three transformers or two transformers and a large ground reactor). When using the Scott connec-

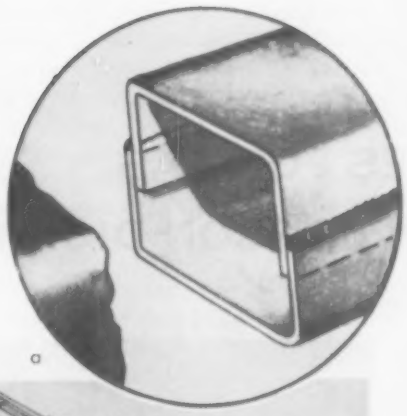
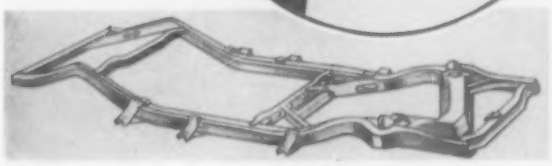
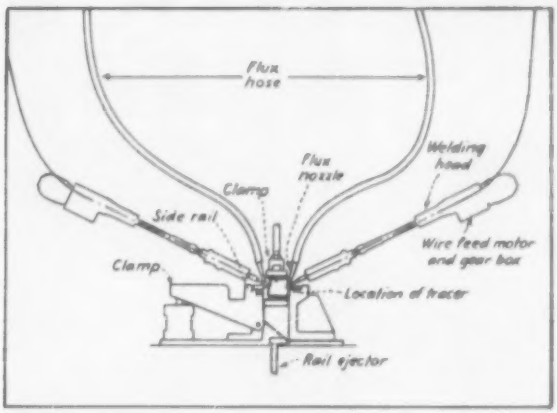


Fig. 15 Three o'clock welding of automobile frames. Welds are made simultaneously from both sides

a



b



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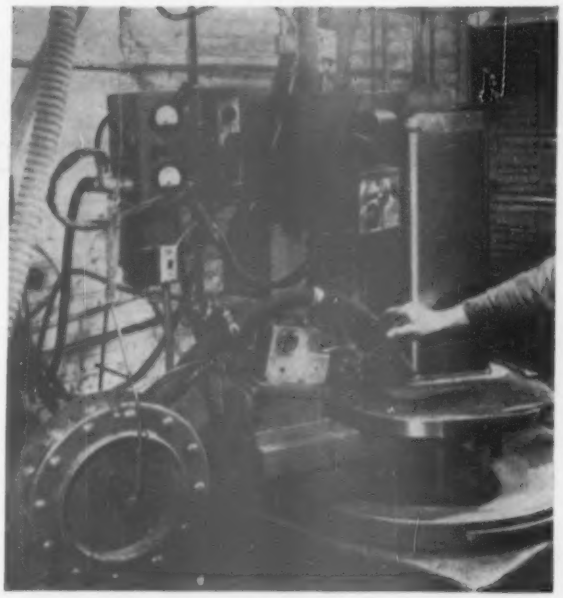

Fig. 16 Bottom stamping is welded to body of rectangular can in the three o'clock position. Can is rotated

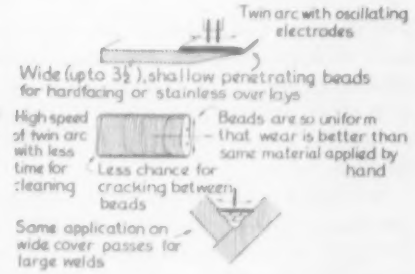
Twin arc with oscillating electrodes
Wide (up to 3½), shallow penetrating beads for hardfacing or stainless over laye
High speed of twin arc with less time for cleaning
Beads are so uniform – that wear is better than same material applied by hand
Less chance for cracking between beads
Same application on wide cover passes for large welds

Fig. 17 When to use spread-arc welding

tion, special taps on the secondaries should be available to balance the voltages and to facilitate picking the proper phase angle.

(6) *D-C Rectifiers.* While hand-welding rectifiers are becoming increasingly popular because of low-noise level and no moving parts, they are handicapped for automatic use by being subject to changes in output whenever input line voltage changes. When this difficulty is eliminated and the proper volt-ampere characteristics are developed, they can be used in much the same manner as d-c motor generators, with the exception that secondary line contactors are required to make and break the welding current. This is a handicap on some arc-striking applications.

Special Applications

Three O'Clock Welding

This is the name given to horizontal welds with the workpiece approximately in the vertical plane (Fig. 14). When making a weld on both sides of the plate, one electrode comes in at, roughly, the 3 o'clock position, and the other, at 9 o'clock (Fig. 15). This departure from the normal practice of welding down hand permits welds to be made on both sides of a joint at the same time. Irregular contours in the vertical plane, which cause the molten metal to run off, may become a horizontal weld when done in the 3 o'clock position, thus reducing the tendency for the metal to spill (Fig. 16).

The molten metal is held in the joint until it freezes by the damming action of the granular flux covering the arc which must be held in place by special flux dams. Very small round-about welds, impossible with the work horizontal, can often be made when the work piece is rotated in the vertical position. Fairly low currents and high travel speeds must be used so that the weld metal "sets up" quickly. For this reason, large welds must be made in multiple passes.

Spread-Arc Welding

Wide, flat beads up to three in. in width can be made by automatically weaving the electrode at right angles to the direction of travel (Fig. 17). Since it is desirable to obtain high-deposition rate and shallow penetration, the twin-arc process is ideal for use in connection with an oscillating device. This process is used extensively for build-up work, cladding and hard surfacing with alloy fluxes. Because of the relatively large molten area, it is used on fairly flat surfaces.

MILD-STEEL ELECTRODES FOR GAS METAL-ARC WELDING IN CARBON DIOXIDE

Investigation shows that killed and semikilled steel produce higher quality welds than rimmed steel using both carbon dioxide and argon-oxygen gases

BY JULIAN D. CAREY AND ROBERT D. MANN

The welding of mild steel is one of the most promising fields of application for the consumable-electrode gas-shielded process. To properly utilize this process, as with other welding processes, it is of major importance to use the proper combination of electrode and base metal.

A project was undertaken to determine the best performing mild-steel electrode analysis for use with (1) 100% carbon dioxide, and (2) 5% oxygen, balance argon-shielding gases. This analysis would then become a basis for selecting a standard mild-steel welding electrode.

To obtain this data, it was necessary to know whether some electrodes would be less critical than others with regard to settings of wire feed speed, arc length, mechanical properties, plus a measure of their performance on the three basic grades of mild steel; i.e., rimmed, semikilled, and killed.

Six Widely Used Electrodes Tested

Six of the most widely used commercially available electrodes were selected for testing. All were $^1/_{16}$ in. diam and were spooled for this process. The equipment used to make the test welds is shown in Fig. 1. This setup permitted us to maintain a close control over such welding variables as arc length, current, travel speed, wire feed and torch position.

Commercial grades of steel plate were purchased from the mill for all tests and, to maintain uniformity, all plate was low carbon, hot rolled, pickled, and oiled. Three grades (rimmed, semikilled and killed) were used. Table 1 shows the analysis of this steel.

Julian D. Carey and Robert D. Mann are associated with General Electric Co., York, Pa.

Paper presented at AWS 1955 National Fall Meeting in Philadelphia, Pa., October 17-21.

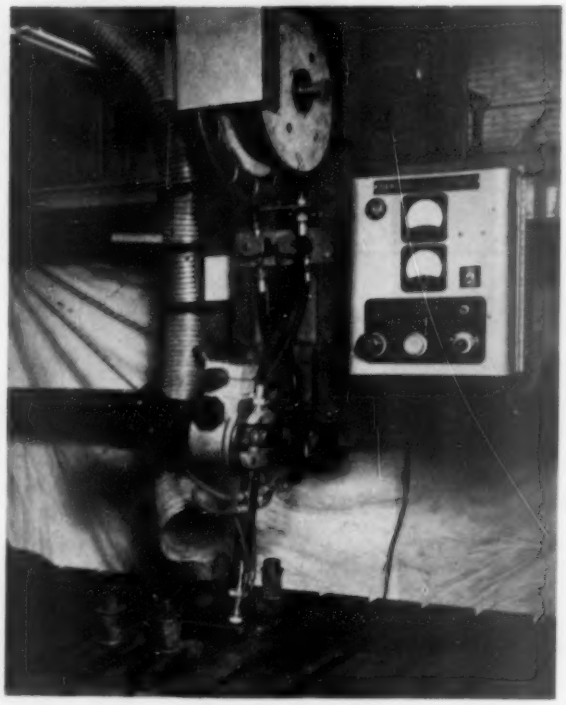

Fig. 1 Equipment used to make test welds

Table 1—Chemical Analysis of Rimmed, Semikilled and Killed Steel Used for Electrode Evaluation

	Type of steel plate		
Element	*Rimmed, %*	*Semikilled, %*	*Killed, %*
Carbon	0.05	0.08	0.26
Manganese	0.31	0.33	0.60
Silicon	Nil	0.07	0.22
Phosphorus	0.006	0.007	0.015
Sulfur	0.010	0.015	0.023

Battery of 11 Tests Conducted

Each electrode was evaluated in the same manner. First, a series of beads were welded on $^1/_4$-in. plate. These were cross sectioned and examined for penetration, porosity, contour, and surface condition. In addition, they were examined radiographically and, where carbon dioxide was used, the degree of spatter was noted.

Butt welds were made on 1/4-in. plate with and without edge preparation. These were examined radiographically for porosity. Tensile tests were then made on welds which did not show excessive porosity.

All-weld-metal test specimens were prepared to evaluate the mechanical properties of the electrodes. This test was considered valuable since it showed the transfer efficiency of the elements, the effect of multipass welding, and the true mechanical properties of the deposited metal.

Free bend tests were made on 1/4-in. butt welds. These were given the bend test to measure the relative performance in bending of deposits made with the various electrodes. The results of this test are shown in Table 2.

Figure 2 shows a typical photomacrograph of a carbon dioxide butt weld, showing also a microhardness traverse through the weld zone. This method of hardness testing was used to determine the hardness gradient from the base metal into the weld metal. It was felt that any increase in hardness, due to carbon pick-up (Table 3) when using carbon dioxide, would be observed. Figures 3 and 4 show curves plotted from microhardness measurements taken through carbon dioxide and argon-oxygen butt welds.

Microscopic examinations were made on joints welded with the various electrodes. No appreciable difference in microstructure was detected between the various electrode deposits when welded with the same gas. It was noted, however, that the bead contour of welds made with carbon dioxide differed from those made with argon-oxygen. The carbon-dioxide shielded weld had a wide penetrating pattern compared to the finger-like penetration of an argon-oxygen shielded weld.

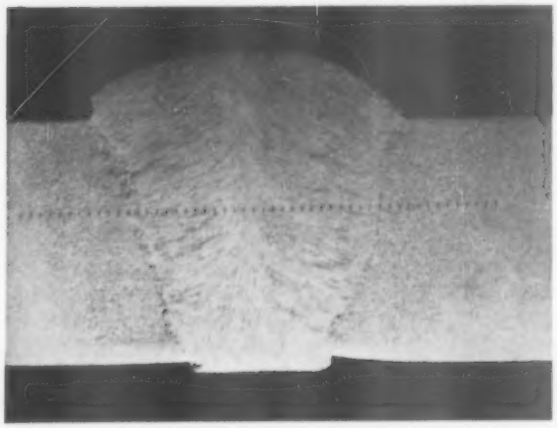

Fig. 2 Macrophotograph of butt weld made with 100% CO^2 gas showing microhardness traverse

All wires produced sound beads on rimmed, semi-killed and killed plates using both gases. The high-silicon wire produced excessive slag with both gases and

Table 2—Free Bend Tests on Rimmed Steel

Electrode	*100% Carbon dioxide; % Elongation at weld face*	*5% Argon-oxygen; % Elongation at weld face*
A	50	44
	39	45
B	31	64
	31	49
C	38	40
	41	41
D	24	55
	30	43
E	29	45
	70	39
F	50	45
	32	54

Table 3—Carbon Transfer of Electrodes Using 100% Carbon Dioxide and 5% Argon-Oxygen Gas

Electrode	*Wire analysis, %*	*Carbon dioxide deposit, %*	*Argon-oxygen deposit, %*
A	0.11	0.13	0.10
B	0.18	*	0.14
C	0.12	0.12	0.11
D	0.06	0.09	0.06
E	0.05	0.09	0.05
F	0.09	0.12	0.10

* This electrode did not produce a satisfactory all-weld-metal deposit.

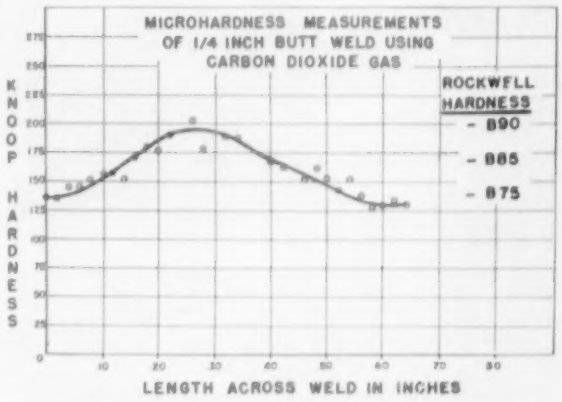

Fig. 3 Microhardness traverse of 100% CO^2 butt weld

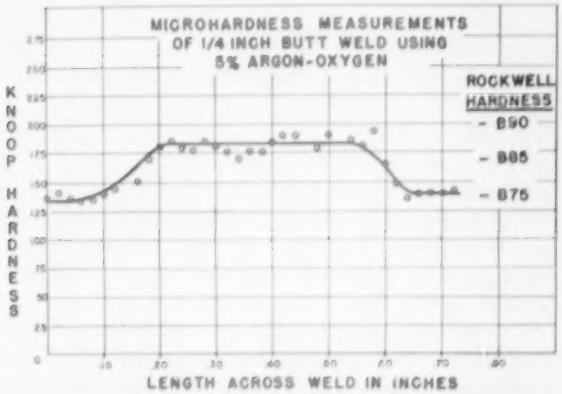

Fig. 4 Microhardness traverse of 5% argon-oxygen butt weld

Table 4—Comparison of All-Weld-Metal Mechanical Properties Using 100% Carbon Dioxide and 5% Argon-Oxygen Shielding Gas

Commercial electrode alloy	Ultimate tensile strength, psi		Yield strength, psi		Elongation, % in 2-in.	
	100% CO_2	5% Argon-oxygen	100% CO_2	5% Argon-oxygen	100% CO_2	5% Argon-oxygen
A	82,700	75,400	69,400	62,800	5	27
B	*	76,250	...	62,925	...	25
C	80,100	77,900	66,900	67,300	20	10
D	108,100	83,500	89,400	70,300	6	15
E	84,500	82,750	73,900	72,600	18	17
	86,000	77,700	73,000	67,200	23	21
F	81,490	74,600	70,900	63,000	19	25
	83,600	...	69,420	...	16	..

* All-weld-metal deposit too porous to obtain acceptable test bar.

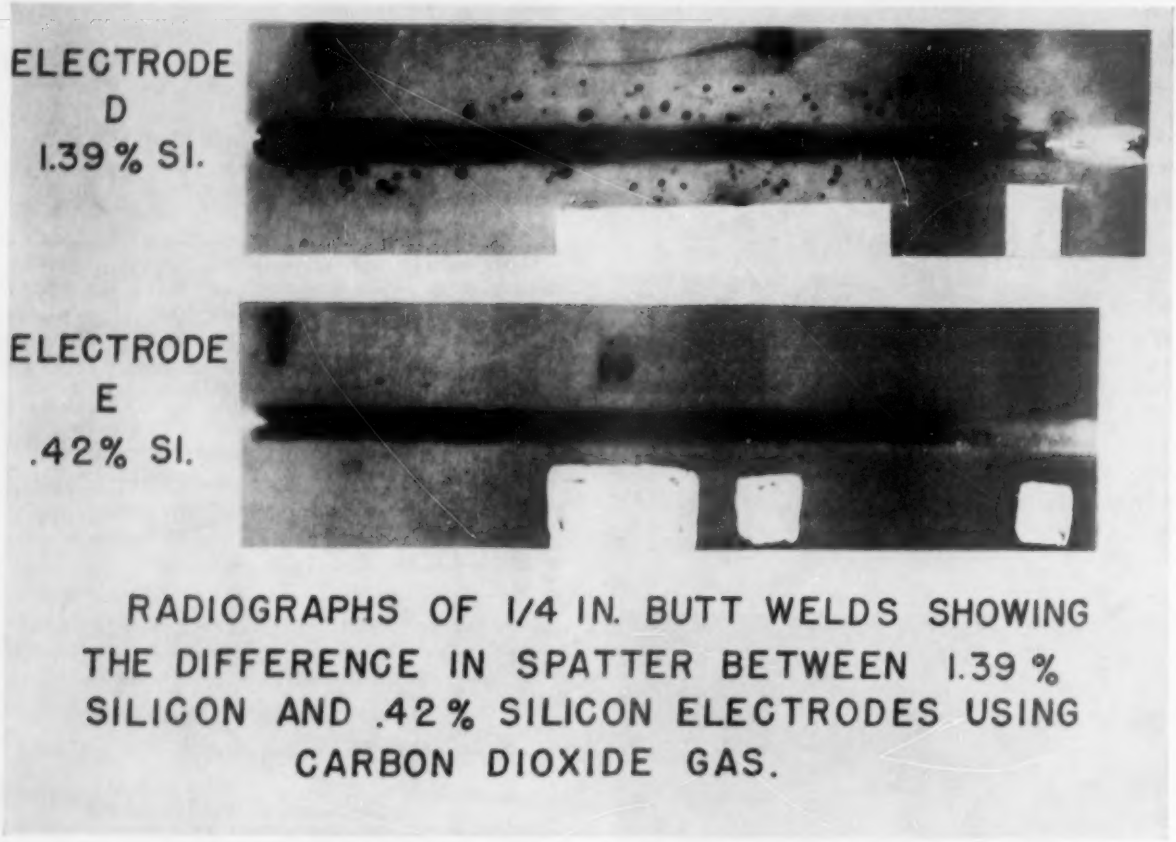

Fig. 5 Radiograph showing the increase in spatter with a high-silicon wire

excessive spatter with carbon dioxide. Figure 5, a radiograph, shows the difference in spatter between one of the better electrodes and the high-silicon electrode.

Radiographs of the butt welds on $^1/_4$-in. plate showed an appreciable difference in porosity between the electrodes. When these welds were tested in tension, all breaks occurred outside of the weld, as shown in Fig. 6. This was considered normal since the higher silicon and manganese content of the deposited metal produces strengths greater than the base material. In addition, any carbon pick-up from carbon dioxide would increase weld-metal strength.

The mechanical properties obtained from all weld metal tension tests (Table 4) showed that a wide variation in properties exists between electrodes and between shielding gases used. Note the difference in elongation for weldments made using carbon dioxide. Electrodes A, B and D were very low. Sample B consistently produced welds too porous to permit the machining of a test bar. Sample C, while having good mechanical properties, would not consistently produce porosity-free welds.

Two Electrodes Out of Six Pass Tests

This test narrowed the range of acceptable electrodes to E and F. It was noted that reasonably good welds were produced with all electrodes when argon-oxygen was used.

The analysis of the two electrodes (E and F) which performed well on both carbon dioxide and argon-oxygen was studied (Table 5). A wide variation in manganese content was noted (1.23% for E and 0.88% for F). Both alloys had carbon lower than 10%.

The silicon was close, being 0.42% for E and 0.36% for F, and the aluminum ranged from 0.02% to 0.01%.

Table 5—Chemical Composition of Electrode Alloys Evaluated

Electrode alloy	*Values, %*				
	Carbon	*Manganese*	*Silicon*	*Aluminum*	*Others*
A	0.11	0.94	0.38	<0.01	...
B	0.18	1.15	0.24	<0.01	...
C	0.12	1.07	0.23	0.02	...
D	0.06	0.94	1.40	0.01	...
E	0.05	1.23	0.42	0.02	Titanium low
F	0.09	0.88	0.36	0.01	...

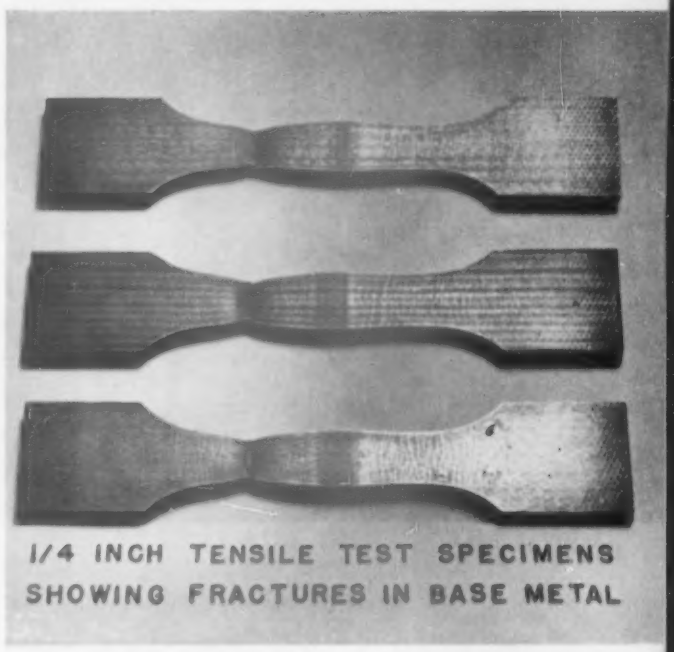

Fig. 6 Tensile test specimens showing the fracture outside of weld zone

Since the two most satisfactory electrodes did not vary drastically in chemical composition from the others, it was felt that the steel making practice played an important role in determining ultimate performance. To date, no electrode surface chemistry study has been conducted. It is believed that surface films remaining from drawing lubricants play an important role in electrode performance and weld quality.

Excessive Arc Length Produces Porous Welds

During the investigation, another important fact was noted when carbon dioxide gas was used. All electrodes produced porous welds when the arc voltage, measured at the torch, was increased above 32 v. This voltage produced an arc length $^1/_8$ in. above the surface of the base metal. Figure 7 shows three X-rays that will demonstrate this. Although one-sixteenth inch electrodes were used in this test, it is felt that the relation of arc voltage to porosity could change for other electrode sizes. In general, the arc length at 32 arc volts is considered too long for high-quality spatter-free welding. Most carbon dioxide welding with $^1/_{16}$-in. diam electrodes is conducted using lower arc voltages.

This investigation showed that killed and semikilled steel produced higher quality welds than rimmed steel using both gases. Carbon-dioxide shielding produced higher quality welds on rimmed steel than argon-oxygen.

Since only two of the six electrodes tested were satisfactory for use with both carbon dioxide and argon-oxygen, it is felt that a great need exists for development in the field of mild-steel consumable electrodes.

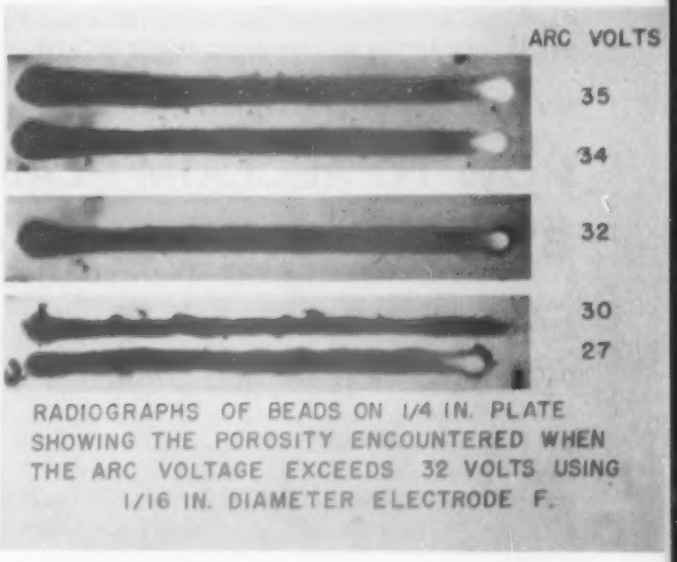

Fig. 7 Radiograph showing the increase in spatter with higher arc voltages

Fig. 1 One of the 50-cwt half shoes for the 12-ton steel shaft nearing completion. Note the tee bars tack welded to open ends to prevent undue distortion during welding and heat treatment

HOW TO RECLAIM PLANT AND MACHINERY BY PRACTICAL WELDING APPLICATIONS

Oxyacetylene, metal-arc and carbon-arc welding processes used to make many of the difficult repairs required by typical maintenance and reclamation applications

BY G. GORDON MUSTED

ABSTRACT. This paper presents some typical examples of maintenance and reclamation problems, and explains how to do this class of repair work, especially heavy sections. It shows how these were made good and safe for further service, thus preventing "bottlenecks" in production, and thereby increasing productivity at lower cost by use of practical welding applications by the use of (1) oxyacetylene welding and cutting, (2) electric metal-arc welding and (3) the carbon-arc process.

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Introduction

The work described in this paper shows how economy by efficient maintenance bears a direct relation to increased production and, when the work is carefully planned, welding offers many opportunities because of its practical application to existing structures.

Many failures of plant and machines are directly attributable to inadequate maintenance. Thus cracked foundations or loose fixing bolts are a common cause, and it is necessary to have these defects rectified before

the question of the repair can be considered.

In planning the repair to be carried out, it is important to ascertain the type of material involved, because this will indicate whether or not the repair can be successfully carried out by welding. A knowledge of the material composition will indicate the welding technique to be employed and the heat treatment required.

This paper covers three groups of repair which may be summarized as follows:

(1) Reclamations of heavy steel sections
(2) Preventive maintenance by hard surfacing
(3) Reclamations by "make do and mend repairs"

The first group refers to heavy sections such as steel shafts, and drop hammer frames which can be reclaimed by simple economical methods, using a slightly different welding technique.

The second group involves preventive maintenance by hard surfacing new parts subject to excess wear or corrosion, before they go into service.

The third group includes many cast-iron parts considered beyond repair by welding which can be reclaimed by use of the "make do and mend" method of repair. The technique of "make do and mend" is a combination of some form of suitable mechanical reinforcement that will give sufficient rigidity to the defective area, and, in the case of pressure work, sealing by gas or arc welding, using either ferrous or nonferrous filler rods and electrodes.

It is not suggested or intended that the latter method of repair should replace an all-welded repair using orthodox full-fusion gas or arc welds; it is only recommended when a full preheat is not possible, or when the cost of dismantling and re-assembly would make such repairs uneconomical.

The variety of conditions and the nature of repairs are so great, that it is impossible to formulate any hard and fast rules or methods to be used for reclamation and repair welding.

However, an effort has been made in this paper to show how practical welding applications were successfully employed to reclaim defective parts.

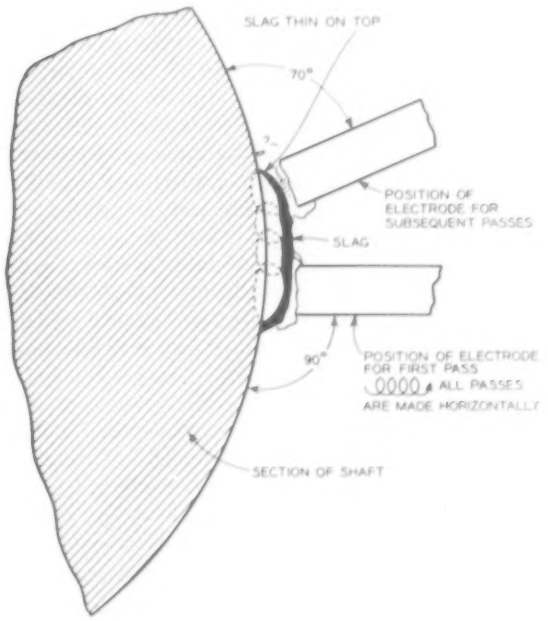


Fig. 2 Section of shaft showing position and angle of electrodes for the deposition of continuous beads on vertical surfaces without removing the slag after each bead of weld metal

Twelve-Ton Steel Shaft Reclaimed to Service

Loose fixing bolts locating two half shoes, each weighing 50 cwt, caused excess surface wear to such an extent that production was stopped in the middle of an important contract. New parts were unobtainable quickly enough to get this rolling machine back again in service to complete a large export order.

It was decided to build up the worn surface on all the cams with an overlaying weld deposit $^5/_8$ in. in thickness, to allow for machining to the finished dimensions. The analysis of this material was 0.808% C, 0.68% Mn, 0.07% Cr, 0.05% Ni, and 0.02% Mo; this meant that heat treatment would be required to insure sound weld deposit and good machinability. The half shoe sections were removed, but the main shaft was left in position in its own bearings to facilitate handling operations for preparation, preheating and welding.

The defective area was prepared by filing and grinding, followed by preheating with coal gas bunsens to about 200° F for 14 hr prior to welding, and postheating for 6 hr after all welding was completed.

Welding was carried out by two operators (one on each side) working simultaneously, using $^1/_4$ in.-diam low-hydrogen-type electrodes to obtain an overlay of $^5/_8$ in. by superimposed beads on the sides of the shaft, with eight beads made horizontally without removing the slag from the previous beads. The shaft was rotated to make similar beads to distribute the heat throughout the shaft, and a flat, smooth overlay of weld deposit was obtained, free from porosity and easily machined afterwards.

Briefly, this technique consists of first depositing a straight bead horizontally, with the electrode perpendicular to the side of the shaft as indicated in Fig. 2. This forms a ledge or shelf on which the subsequent beads can be made without chipping off the slag after each run. The position of the electrode for making the subsequent beads is 70° to the side of the shaft, with an angle of 70° for welding. In this way it was possible to make continuous beads without removing any slag, because the slag tends to fall down out of the way, leaving a thin skin of slag on the topside of the deposit, which is easily removed when making subsequent superimposed runs.

Considerable saving of time is obtained when this technique is employed, each bead merging evenly into the previous bead. The experienced welder has full control of the weld deposit, and the latter has a nice

Fig. 3 Welded 12-ton shaft ready for dismantling. Note overlays on the cams. Built up in the vertical position with $^1/_4$ in. diam low-hydrogen type electrodes without removing the slag

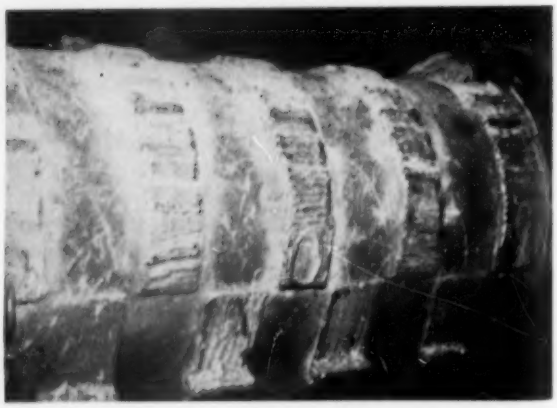


Fig. 4 Close up view of steel shaft before removing the slag

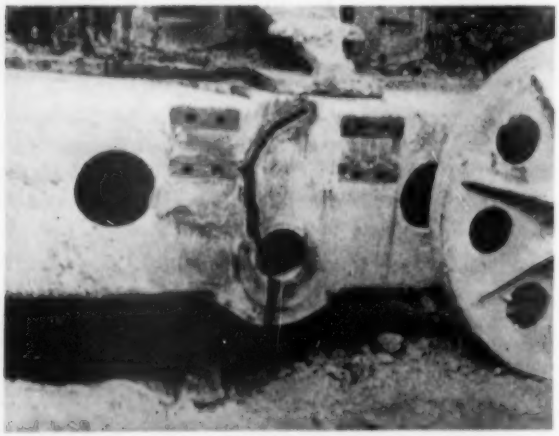


Fig. 5 Fourteen-ton drop hammer frame after defective metal was removed by oxygen cutting

smooth finish after machining.

Figure 3 shows the shaft ready for dismantling from the machine. Figure 4 shows a close-up of the welds before removing the slag which comes away quite easily when cold.

Reclamation of Half Sections for 12-Ton Steel Shaft

The cams on the half sections working in conjunction with the 12-ton steel shaft required building up in a way similar to that of the main steel shaft. The material was identified as being suitable for welding with heat treatment of 200° F. However, owing to the shape of the casting, three tee bars were tack welded to the open end to prevent undue distortion during heat treatment and welding. The defective cams were prepared by filing and grinding, and then preheated to 200° F by coal gas bunsens, this temperature being maintained during the welding operation. Low-hydrogen type electrodes, $^1/_4$ in. diam were used with a technique similar to that used for the main shaft. The repaired section was allowed to cool down slowly. The slag was removed and the weld size checked before machining.

The lead photo, Fig. 1, shows one of the half sections nearing completion. The tee bars clamping the open end were removed before machining. This work was completed in three weeks, including time for dismantling, preheating, welding and assembly.

Reclamation of 14-Ton Drop Hammer Cast-Steel Frame

This frame was of typical box-section design, and had a bad crack on one side, with small transverse cracks along the edge of the main crack. The material was suitable for welding, and was prepared by cutting out the defective metal with the oxyacetylene flame. Figure 5 shows the casting after the defects had been cut out leaving a gap of $1^3/_4$ in. The defective side was positioned on top, and the casting preheated to 200° F by coal gas flame. Welding was carried out in two stages. First, a steel backing bar held in position by bolts was tack welded; the bolts were then removed, and a "U"-type joint built up with six passes of $^1/_4$ in.-diam low-hydrogen-type electrode, working in the downhand position. Figure 6*A* shows how this "U"-type preparation was obtained. The casting was then set up with the defective area in the vertical position for the second stage of final welding. This consisted of depositing heavy fillet welds in the "U" at the back of the gap, and fillet welding each side working from the back to the front of the gap; the center of the fillet passes were then joined by a weavebead working from the back to the front of the gap, when a final bead pass was made to each side of the casting, in the front. Figure 6*B* shows method of final welding. It is to be noted that the slag was removed after every pass.

Figure 6*C* shows operator welding in the vertical position with special downhand technique planned for this job. The results were very satisfactory, and the job was completed in 6 days.

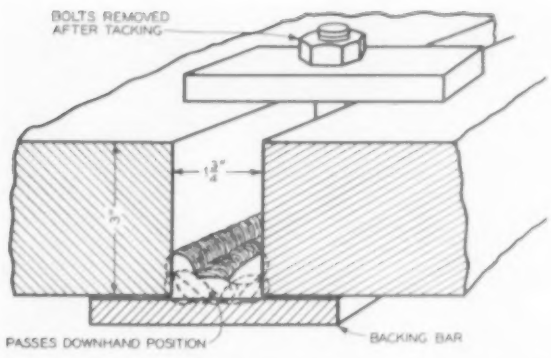


Fig. 6A Section of "U" type preparation built up by six passes to the steel backing bar, by downhand welding with 1/4 in. diam low-hydrogen electrodes

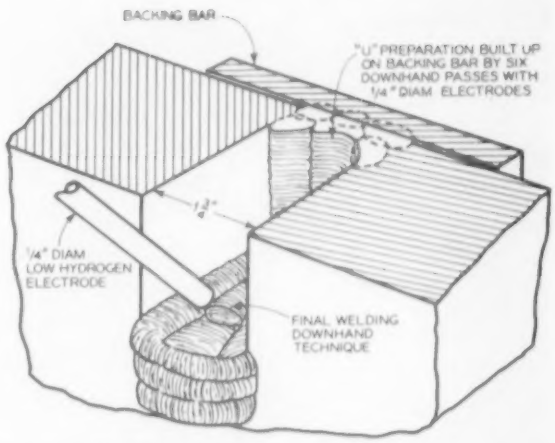

BACKING BAR
"U" PREPARATION BUILT UP ON BACKING BAR BY SIX DOWNHAND PASSES WITH 1/4" DIAM ELECTRODES
1¾"
1/4" DIAM LOW HYDROGEN ELECTRODE
FINAL WELDING DOWNHAND TECHNIQUE

Fig. 6B Method used for welding the drop hammer frame in the vertical position by downhand welding

Preventive Maintenance by Hard Surfacing

One of the best practical applications to prevent maintenance, is to hard surface new parts before they are put into service, especially when it is anticipated that the new parts will be subject to excess wear and corrosion; otherwise, the new part may become irreclaimable.

The well-known established processes generally used for hard surfacing are: oxyacetylene, metal-arc and carbon-arc welding. These processes have a very wide field of application for hard surfacing new parts for dredging and grinding machinery, and similar parts subject to friction, impact and abrasion. This type of deposit is usually not easily machined, but can be ground or, in some cases, hammer forged to shape while the deposit is still red hot. While the cheaper types of hard-surfacing metals are suitable for a wide variety of applications, they are not suitable for the hard surfacing of new parts which necessitate "hot hardness" and corrosion resistance.

The more expensive types of hard-surfacing metals should always be used when it is necessary to hard surface hot metal working tools. However, due to their comparatively high cost, it is most essential to apply them economically; otherwise, the cost of application will defeat the many advantages gained.

However, certain specialized processes have been developed specifically for the deposition of "surface" deposits. These include: (*a*) paste methods, and (*b*) methods which combine metal spraying technique with welding, or fusing alloys sprayed in powder form to provide a smooth, homogeneous, solid-metal overlay of close dimensions.

Paste Method

This consists of spreading a special paste to the part to be hard surfaced, this is fused by the oxyacetylene torch flame, or by the carbon-arc process, this overlay is not machinable, and should only be used on parts that can be put into service in the "as-welded" condition, and has many useful applications.

Fig. 6C Welding in the vertical position with special downhand technique

Powder Spray Method

This method is excellent for hard surfacing large quantities of duplicate parts which can be set up in the lathe. The part should first be grit-blasted to prevent lifting during the fusing operations. After preparation by grit-blasting, the alloy coating is sprayed to the surface by rotating the part in the lathe to provide an overlay to the required dimensions, when a mechanical bond is obtained. Fusion of the nickel-base alloy is obtained by use of the oxyacetylene flame. Figure 7, illustrating the set-up in the lathe, shows the operator fusing the deposit on a pump sleeve.

Other Examples of Preventive Maintenance

A test was made to check the wearing properties of

Fig. 7 Fusing alloy sprayed deposit on a pump sleeve surface with the oxyacetylene flame to provide a welded bond capable of resisting wear and corrosion

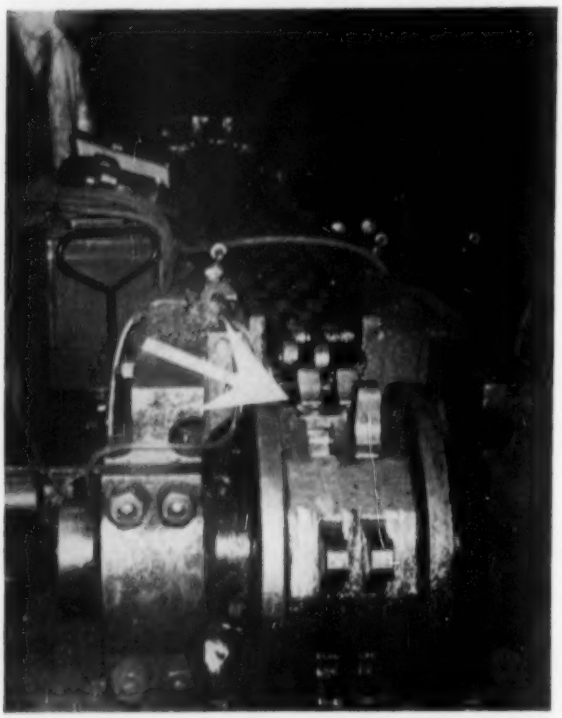


Fig. 8 Repair to cast iron sprocket wheel in position. Arrow indicates the steel plate replacing missing section of cast iron

hard surfacing, and was carried out with a pump spindle running in severely corrosive and abrasive conditions. The normal shaft spindle used for this test was made of stainless steel, and the average life was 14 days.

A similar shaft was made of mild steel, and hard faced by powder-spray process, and put in service, and after 11 months of continuous service was still in use with very little wear apparent. This shows that preventive maintenance by hard surfacing new parts when wear is anticipated is a practical proposition, especially if inexpensive base metals can be used in place of special alloys.

Reclamation by "Make Do and Mend Repairs"

Figure 8 shows a main drive sprocket wheel which was considered beyond repair but which was successfully salvaged by the "make do and mend" method. The sprocket wheel was cast iron, and the diam was 3 ft 10 in. with six flats, and the sprocket was 20 in. thick. Each flat carried two steel teeth $1^1/_2$ in. thick. The snatching of the main steel chain drive pulled out two teeth, taking part of the cast iron with them. The thickness of the missing cast iron was just over 1 in. thick; this was replaced by a steel plate 1 in. thick, and was held by four steel studs, $^5/_8$ in. diam, which were finally secured by arc welding to the steel plate.

The center of each steel tooth was then machined out and a $^7/_8$-in. diam hole was drilled right through. The teeth were then fixed to the wheel by means of a stud,

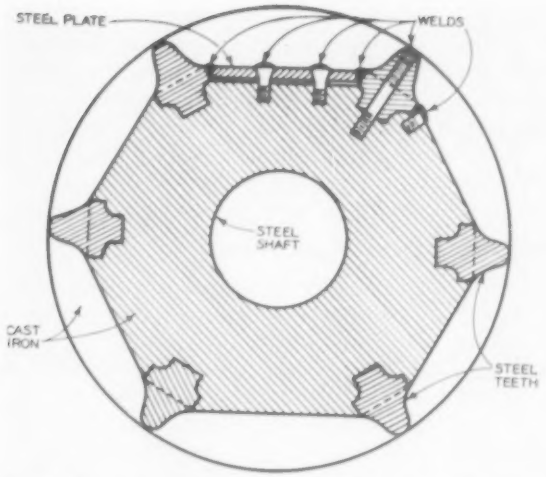


Fig. 9 Section through the cast iron sprocket wheel showing method of "make do and mend" repair

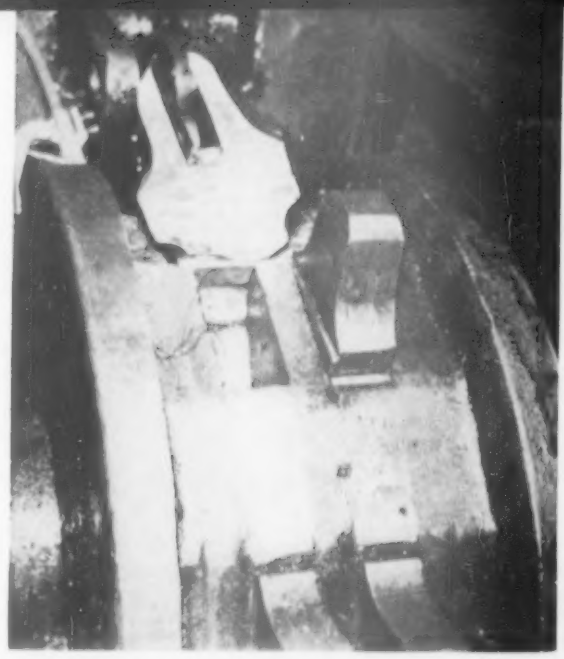


Fig. 10 Defect in cast iron sprocket wheel, showing one tooth machined for fitting

and finally secured by drilling and fitting steel studs on the opposite side to the steel plate, as shown in Fig. 9 which illustrates the general arrangement of this work.

Steel-to-steel welds were then made, using low-hydrogen-type electrodes between the studs and the teeth and to connect the base of the teeth to the steel plate. The slots were welded up in the steel teeth by low-hydrogen electrodes, and made flush by grinding and filing. Figure 10 shows one of the teeth machined out ready for fixing.

This job was carried out without dismantling or preheating, and consequently quickly repaired in position.

The machine in question is used for making solid drawn copper tubes, and is very old. A new sprocket was not available from the makers, and would have to be specially made. However, the machine is back in production and working very satisfactorily.

Welding Unequal Sections by Tube Insert

Another interesting "make do and mend" repair was carried out, using steel tube inserts, on a cast-iron flywheel which had one spoke fractured near the outside flange.

Dimensions of this flywheel were: 3 ft diam by 10 in. thick (6 in. deep at flange); the boss was 7 in. diam by 10 in. thick with spokes $1^1/_2$ in. thick and 3 in. wide.

The first operation was to cut out the defect by electric arc so as to be able to position a $1^1/_2$ in.-diam steel tube insert (see Fig. 11). The surface oxide was removed by filing and grinding. Next, the spoke of the base casting was "buttered" using bronze electrodes. The first pass was made at top right hand corner and the second at the bottom left hand corner, peening while still hot after each pass. After this, the 3 in. long tube was inserted as shown in Fig. 11.

Following this the welding on the steel tube began (see Fig. 12). The welding continued in a similar manner to that of the first bead pass to the tube. Again each pass was peened while hot; the dotted line

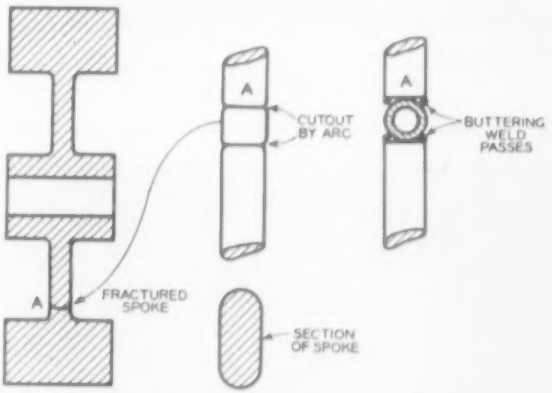
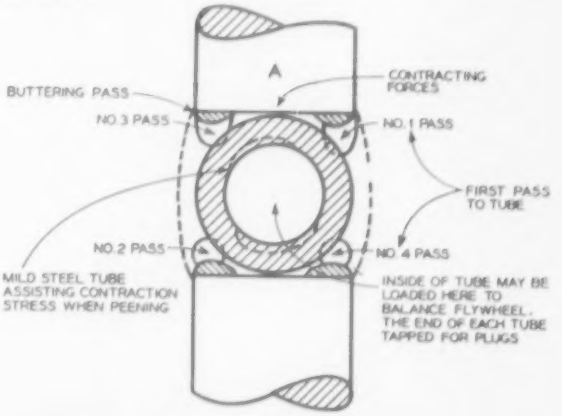


Fig. 11 Preparation of spoke in cast iron flywheel for a "make do and mend" repair without preheating

Fig. 12 Method of welding cast iron spoke, showing how the steel tube insert assists contracting stress when peening each pass


A
CONTRACTING FORCES
BUTTERING PASS
NO.3 PASS
NO.1 PASS
FIRST PASS TO TUBE
NO.2 PASS
NO.4 PASS
MILD STEEL TUBE ASSISTING CONTRACTION STRESS WHEN PEENING
INSIDE OF TUBE MAY BE LOADED HERE TO BALANCE FLYWHEEL. THE END OF EACH TUBE TAPPED FOR PLUGS

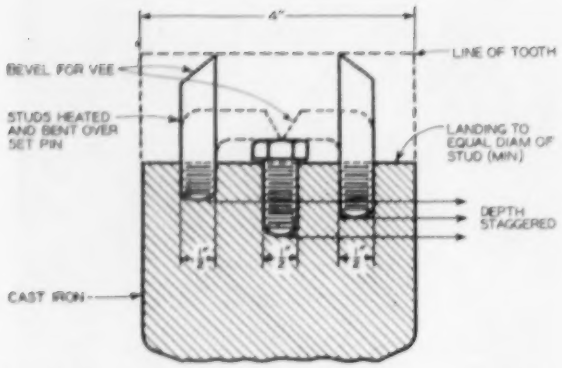


Fig. 13 Method of building up broken gear wheel tooth

shown in Fig. 12 indicates the final contour of the finished welds.

The tube insert acting as an expansion joint during the welding operation, was no longer concentric.

To obtain perfect balance after welding, it was necessary to ream out the tube for tapping to suit standard plugs. The flywheel was then mounted on a shaft and checked for balance. A true balance was obtained by adding lead shot, the plugs being finally secured by center popping.

This flywheel was part of a large press, and a serious "bottleneck" was eliminated as the result of this repair which was carried out without any preheating, apart from warming up before commencing to weld. The sequence of continuous welding supplied sufficient mechanical heat to avoid undue locked up stresses.

The work was completed over the week end, and the press is still working on full production.

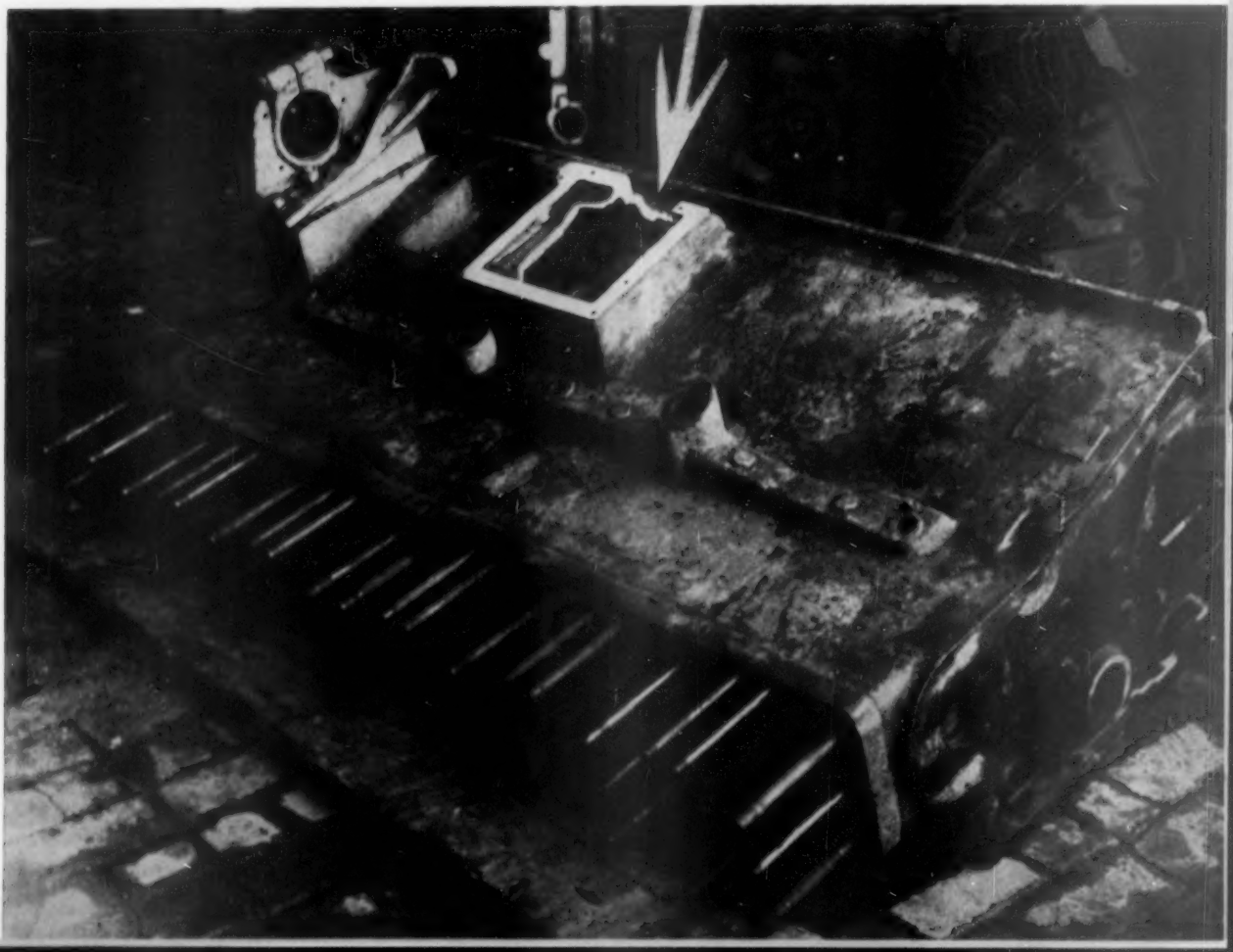
Reclaiming Gear Wheel Teeth

A "make do and mend" method of repairing broken teeth in cast-iron wheels is illustrated by the following example.

The defective area is made flush, and steel studs or bolts are fitted to give greater rigidity to the weld and, at the same time, distributing the stress into the main body of the base casting. The depth of these studs should be staggered to vary the line of thermal disturbance. The studs also should have sufficent landing at the edges, this being equal, at least to the full diam of the stud being used (see Fig. 13).

The center is drilled to take a short set pin, and this is fitted close to the cast-iron face. The two long bolts are fitted next, one on each side of the set pin or stud. These are heated by the oxyacetylene flame and bent over to form a single vee on the center set pin head. The face that is to take the new tooth is then "but-

Fig. 14 Repair of heavy cylinder block. The arrow indicates position and nature of the defect



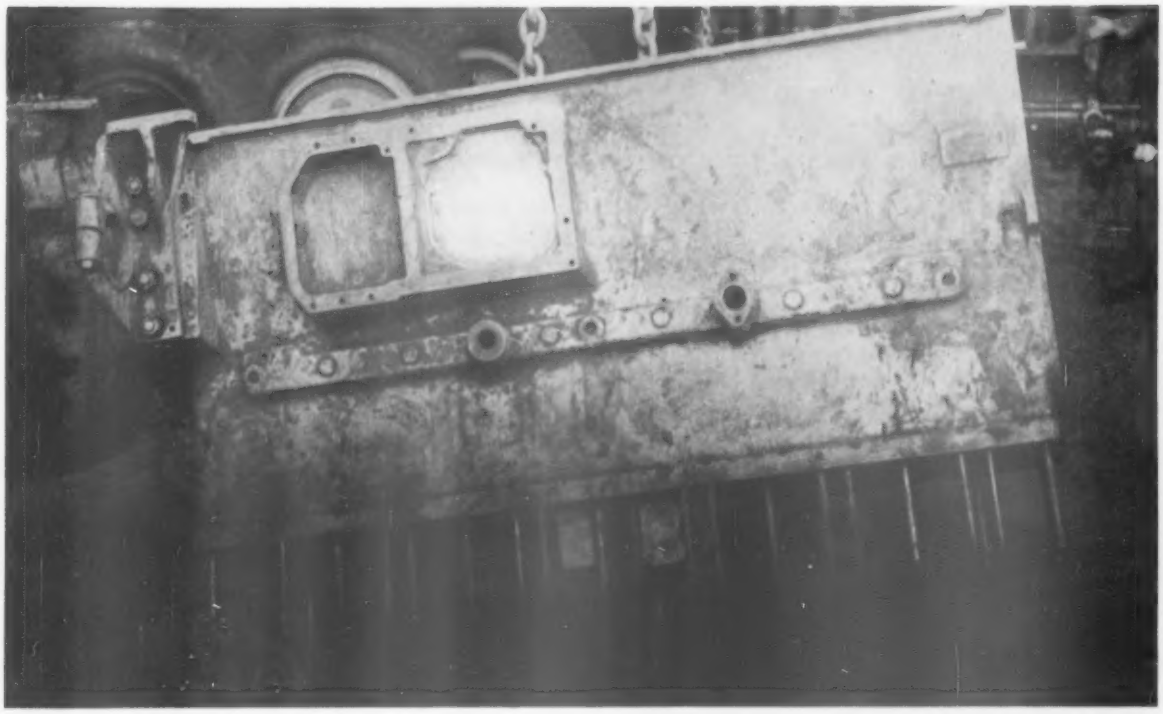


Fig. 15 *The completed repair to the cylinder block. The missing cast iron parts was replaced by dished copper patch, and arc welded with bronze electrodes*

tered" with a deposit from a machinable type of electrode. The final build-up is obtained with phosphor-bronze electrodes.

This method of repair is very satisfactory when using metallic-arc welding, and no machining is required except for final finishing of the built-up tooth, which can be done in position by the fitter.

This method of repair can also be carried out by use of "gas on arc" by using machinable-type electrodes for buttering the face that is to take the new tooth, with final build-up carried out by oxyacetylene welding, using a good-quality nickel-bronze filler rod.

Figure 13 illustrates the general arrangement of three studs. This same arrangement can be used for building up missing edges of cast iron. The size of stud required will depend on the thickness of the casting and the nature of the work it has to do.

Reclaiming Heavy Tractor Cylinder Block

Finally, it may be of interest to describe briefly another example of "make do and mend" method of repair in which dissimilar metals were used. A tractor cylinder block, with extensive fracture and a considerable portion missing, including a section of the heavy flange, was repaired as follows:

The opening was dressed up to give a definite shape and size, and the surface edges to be welded were prepared by filing and grinding. Figure 14 shows the job ready for "buttering." The missing flange was replaced by steel fabricated to shape, and was welded last. All "buttering" passes were made with machinable type electrodes, peening each pass while hot.

The missing thin section was replaced by a patch which consisted of a copper plate flanged at the edges, and slightly dished. The copper patch plate was welded first in easy stages, after the casting had been warmed up to remove the chill. Bronze-type electrodes were used for final welding throughout, peening each pass while still hot, as well as the dished part of the patch plate as welding progressed to assist contraction on cooling.

The heavy steel section was joined to the main body of casting last, and was welded in a similar manner to the patch plate with bronze-type metal-arc electrodes.

The use of bronze electrodes enables this type of repair to be carried out without distortion. Although this type of repair does not give the same finish, as compared with a gas-welded job using silicon cast filler rods, it certainly achieves a considerable saving in time and labor because no dismantling or full preheating is required.

The cost of this type of "make do and mend" repair is about one-third that of the work done by gas welding with a full preheat and dismantling. Moreover, the cylinder block does not distort and does not require reboring afterwards. Figure 15 shows the finished job carried out with bronze-type electrodes for final welding throughout.

Experience indicates that only pressure vessels which have been stress relieved should be accepted for service in agricultural ammonia

BEHAVIOR OF WELDED PRESSURE VESSELS IN AGRICULTURAL AMMONIA SERVICE

BY THOMAS J. DAWSON

Introduction

Anhydrous ammonia has been used for the past 40 yr in commercial service. Refrigeration ammonia plants are familiar to all of us and ammonia disassociation plants for heat treating of steel are common to the heat-treating industry. Ammonia storage vessels, handling ammonia in the anhydrous form compressed to a liquid, have been known for a number of years in the chemical industry and in the fertilizer industry which used it in the manufacture of solid fertilizers.

Standard ASME construction of pressure vessels to meet the vapor pressure conditions for the storage of ammonia have been accepted during this period of time. Cylinders meeting the ICC Regulations have, until recent years, handled a major portion of the product. Although aqua-ammonia had been used for approximately 16 yr for fertilizer on the West Coast, it has been only a few years since Dr. W. B. Andrews at Mississippi State College introduced the idea of direct application of anhydrous ammonia to the soil as a nitrogen supplement to other fertilizing means. Due to the excellent results and rapid expansion of the industry, a large volume of pressure vessels was immediately placed into service.

One state, where a large number of pressure vessels were placed in service, soon experienced a number of failures. A search of the available literature indicated that no appreciable trouble had been experienced previously in the handling and storage of anhydrous ammonia. A fatal accident caused by an explosive type failure, however, immediately prompted state legislative action to provide a better inspection procedure and better controls for the safe handling and storage of anhydrous ammonia which was to be used for agricultural purposes. A survey, requiring retest of the containers, indicated that 3% of them were failing within an average of 3 years service life.

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As is usually the case, the first suspicion of the cause of failure was defective workmanship, and this undoubtedly was a contributing factor in the case of the fatal accident cited above and in other serious failures. A careful investigation was instigated, however, and it was found that similar pressure vessels handling propane gas at similar vapor pressures were not failing under operating conditions equivalent to those used for handling anhydrous ammonia. This prompted the Agricultural Ammonia Institute to formulate a Research Committee to investigate the causes of failure of pressure vessels in anhydrous ammonia service.

The Research Committee has functioned for more than a year and has had the assistance of the Georgia Institute of Technology, Engineering Experiment Station, for the past six months. To date, conclusions have been drawn from various experiments which indicate that, under certain conditions, certain heats of steel, when utilized for pressure vessel containers of the present commercial grade of anhydrous ammonia, are susceptible to stress corrosion failure.

Conditions

A search of the literature indicated history of only the failure of some spheres that were built for a liquid (unspecified) density of 42 lb/ft^3, presumably ammonia, at 50 psi pressure, working stress of 11,000 psi, with a joint efficiency of 90%. The causes of these failures were attributed to notch-sensitive steel as referenced in the Welding Research Council Bulletin No. 17, January 1954.[1] Other checks of the literature brought no indication that stress-corrosion cracking was a contributory cause to failures of pressure vessels in anhydrous ammonia service.

Investigation into the welding quality and construction procedures of pressure vessels in this service pointed to the fact that the welding was within the intent of the ASME Code for U-69 or W-52 construction. Further investigation led also to the apparent fact that all vessels that had failed were constructed to U-69 or W-52 construction, but had not been stress

Typical trailer-mounted transport and tractor-mounted distribution vessels used with anhydrous ammonia

relieved. As usual, although the welding quality in instances was subject to criticism, it was within the intent of the Code construction and was of equal quality to that in pressure vessels built for similar vapor pressure storage of liquefied compressed gases being used in other services such as propane.

The circumstances under which failures occurred were varied in nature. Failures occurred in an underground storage tank, in 500- and 1000-gal field transport tanks, and in 6000- to 30,000-gal storage tanks. But one fact, with few exceptions, was predominant. The tanks that had failed all were manufactured with cold-formed heads and the vessels had not been stress relieved after fabrication.

Investigation of the ammonia used in the agricultural service at the field point gave the following indications:

1. It contained air.
2. An undetermined moisture content was present although it carried the terminology anhydrous ammonia.

Chemical analysis by wet methods of the residuals after boiling off the ammonia and from residues left in ammonia containers after opening them, indicated the presence of chlorides, nitrates, sulphates, cyanides and cyanates. These possibly were induced into the ammonia between the point of manufacture and the point of distribution to the soil. Attempts were made to get anhydrous ammonia analyzed for these constituents. It was found that no procedures exist at present in the chemical field for the quantitative analysis of anhydrous ammonia for the constituents which are believed responsible for stress-corrosion cracking of mild steel. Research is now in work to develop procedures for the quantitative analysis of anhydrous ammonia for future use in that industry.

Stress-Corrosion Cracking Phenomena

Stress-corrosion cracking apparently is a little understood phenomena. It does not have a counterpart nor is it similar to general corrosion which is identified as general wasting away of material; to pitting type corrosion which is identified as pitting in localized areas; nor to general stress corrosion which is identified as accelerated general corrosion and is attributable to overstressing or locked-in stresses. Stress-corrosion cracks in these instances were not indicated by the usual indications of cracking on the outer surface, but were usually detected as a smaller pinhole leak of anhydrous ammonia. Warned by this indication, immediate investigations were made.

Examination of the interior of the pressure vessel indicated numerous cracking points on the interior of the vessels, especially the heads, with possibly only one crack having penetrated to the outer surface in one place. Such failures are nonpredictable from knowledge developed to date as to steel analysis or to degrees of stress other than the general recognition that tensile stresses must be present at or close to the yield point and some heats of steel are more critical than others to stress-corrosion cracking. There are past indications, from work and observations made, that cold work appreciably effects the susceptibility of mild steel to this phenomena. Compression stresses do not pro-

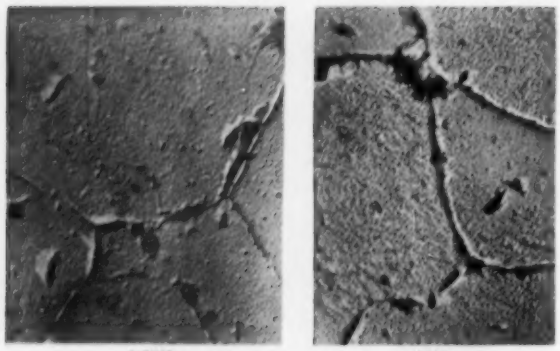

Fig. 1 Electron micrographs shows a comparison between the inside of a pressure vessel head and the outside which has been in agricultural ammonia service. Note the micrograph attack at grain boundarys. (Reduced to 1/3 upon reproduction)

Fig. 2 Typical mud flat type of cracking in cold-formed pressure vessel head after use in agricultural ammonia service

mote such failures presumably because they close any incipient crack and prevent ingress of the corrosion medium to the tip of the crack.

The extremely localized nature of the attack, as Evans[3] has pointed out, means that the anodic area is small in comparison to the cathodic area and that the current density is correspondingly higher, so that the intensity of the attack is high and rapid. Penetration of the metal can occur with relatively little dissolution of the base metal in general. Attack has been observed to the grain boundaries on the inside surface of steel in agricultural ammonia service by comparing this with the outside surface indicating an increase in the width of the grain boundary by the attack, at points other than failure, of several times the normal width; indicating a definite tendency toward grain boundary attack (Fig. 1). Parkins[2] states that it is no more than a statement of the obvious to say that stress-corrosion cracks appear as a result of electrochemical corrosion of a localized zone of anodic material. What is required is an indication of the nature of the anodic material and it is in this respect that alloys susceptible to stress corrosion differ from one another. Evans[4] has recently published a good review of the various theories of stress corrosion so that it will suffice to indicate here only the general features of these theories as they are applied to mild steel. The prevalent theory assumed the corrosive attack to be directed against areas that are chemically or metallurgically different from the matrix of the alloy. Thus, mild steel, under certain metallurgical conditions, can undergo stress-corrosion cracks owing to the collection at the grain boundaries of solute atoms or precipitate particles having potentials which are negative to that of the predominant phase in the alloy.

Unquestionably, these have a very definite bearing on some forms of stress corrosion cracking; however, certain information developed to date indicates the possibilities that differences in potentials may result

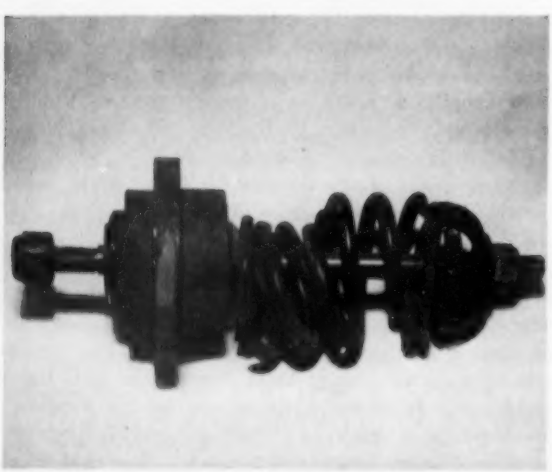

Fig. 3 Safety valve from 30,000-gal ammonia storage vessel which failed in service

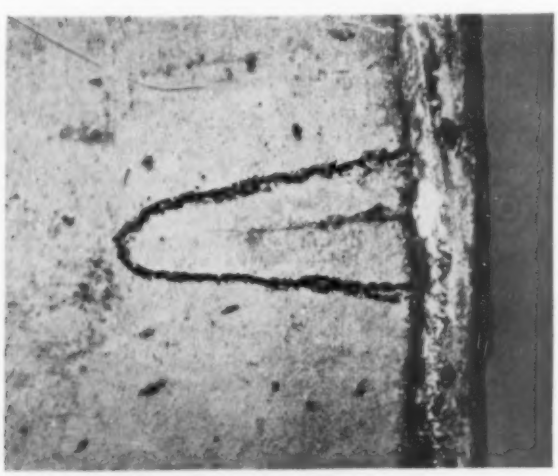

Fig. 4 Failure observed during retest of 1000-gal pressure vessel

in variations of physical strain. There would appear to be a reasonable amount of evidence to support such ideas since it is well known that the lattice in the grain boundary regions of a metallic structure is distorted and that such distortion results in greater chemical activity. Cold working as in cold-formed heads for pressure vessels is of enough intensity apparently to make them sensitive to certain environments. Evidence to date to support such a theory is indicated by the numerous samples that have been investigated (Fig. 2) which showed the mud flat pattern type of cracking or numerous hair-line cracks that stop at the heat-affected zone wherein the metal has been heat treated by the heat of welding. Theories based on these ideas have been put forward to account for grain boundary corrosion in mild steel.

Normally, commercial products such as anhydrous ammonia do not require quality control or handling procedures to maintain purity in the terms of parts per million, these small amounts of impurities are adequate for producing stress-corrosion cracking. Indications are that, since failures not only occur in the liquid zone of the pressure vessel but also in the vapor zone, the corrodent can be in the vapor phase of the material as well as in the liquid. Some indications are that the most active condition is in the vapor phase of products. This is indicated by numerous failures of safety valve springs which in this industry are mounted on the inside of the container (Fig. 3).

Construction and Operation of Pressure Vessels in Agricultural Ammonia Service

Vessels in the agricultural ammonia service are built to the ASME Code for Unfired Pressure Vessels. The vessels, with the exception of the 30,000 storage tanks, are normally constructed without manways for access to the interior of the container. This was considered as acceptable by state control bodies since anhydrous ammonia was considered noncorrosive to steel. Anhydrous ammonia tanks in agricultural service are small applicator tanks ranging from 65 to 250 gal in capacity. These are normally filled in the field from a 1000- gal transport container mounted on trailer or truck by a differential pressure induced by bleeding vapor from the small container to the atmosphere. The 1000-gal containers trailer mounted are used to transport the ammonia from bulk storage plants to the field point of usage; the transfer to these tanks is usually performed by differential pressure induced by a compressor drawing the vapors from the receiving container. Storage bulk plants are normally banks of several 6000-, 8000-, 12,000-, 18,000-, and 30,000-gal containers. These containers are constructed in general to the ASME Code Par. U-69 of the 1949 Code or paragraph W-52 of the 1952 Code. The majority of the tanks are fabricated in the 6000-gal size and smaller. Small pressure vessel plants not equipped with stress-relieving facilities, fabricate the majority of these vessels; therefore, no attempt is made to stress relieve from an economy standpoint by reduction of shell thicknesses as now allowed by the Code.

Table 1—Failure History

Characteristic	*Number*	*Percentage*	*Remarks*
Where			
Not indicated	3	5.2	
Head	47	81.0	Most failures in head
Shell	6	10.3	
Both	2	3.5	
Head type			
Hemispherical	36	62.1	Failure seldom in thinnest portion at the tip of head
Elliptical	12	20.7	
Not indicated	10	17.2	Failure usually in flange or knuckle area
How formed			
Cold formed	37	63.8	
Not indicated	21	36.2	Probably mostly cold formed
Proximity to weld			
Near	22	37.9	Within 2 or 3 in. of the weld
Through	8	13.8	
Far	5	8.6	
Extended	2	3.5	Over a large area
Not indicated	21	36.2	
Appearance			
Radial cracks	24	41.4	Mostly in radial direction
Tears	18	31.0	Cracks over about 2 in. in length.
Crazing	8	13.8	
Pinholes	4	6.9	Tiny cracks in many directions
Explosions	2	3.5	
Not indicated	2	3.4	
Age			
New	8	13.8	
Less than 2 yr	7	12.1	
2 to 5 yr	13	22.4	
Over 5 yr	30	51.7	Many after hydrostatic retest
Cause			
Stress corrosion	36	62.1	
Overstress	12	20.7	
Faulty work	8	13.8	
Brittleness	2	3.5	

Operation Experiences

The heads are predominantly hemispherical cold-formed heads either of the deep drawn type or cold formed in segmental units and welded together. Failures have been observed, however, not only in these two types of heads, but also in cold-formed elliptical heads in 60 in. size and below. Failures have been observed in all the common types of steel used for pressure vessel construction in this service, such as ASTM A-285, ASTM A-212 and steels manufactured under Case 1056 of the ASME Boiler Code Section VIII.[5] From data accumulated it appears that there is no predominance in any particular types of steel, but that certain heats of the steel are more susceptible to stress-corrosion cracking after cold forming than other heats of the same type. As many as 60 and 70% of the heads from one heat of steel have failed as reported by certain manufacturers. Table 1[5] shows the majority of failures to be caused by stress corrosion of the cold-formed heads on the welded pressure vessels.

A typical example of the cracking observed in a head of a 1000-gal ammonia container is shown by Figs. 4 and 5. This pressure vessel was observed to leak upon

Fig. 5 Appearance of crack from inside of head after wire brushing

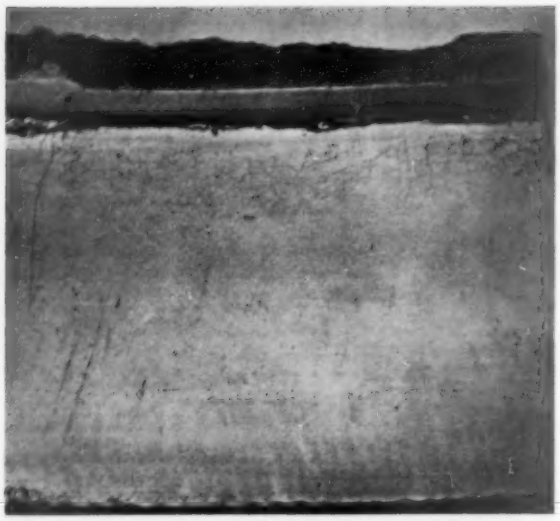

Fig. 6 Area approximately 5 in. long of Fig. 5, after machining away a portion of the backing ring and etched using ammonium persulfate solution

a required retest at a hydrostatic pressure of 275 psig. The pressure vessel was constructed for a working pressure of 250 psig. Chemical analysis of the plates showed it to be A-285 steel with the following analysis:

Carbon	0.16%
Manganese	0.42%
Phosphorous	0.013%
Sulphur	0.036%
Silicon	0.06%
Moly	0.03%
Chromium	0.03%

The following is a description of one of the three cracks discovered in the vessel during the test. When the inside of the head was cleaned, this crack was visible to the eye, running radially to the center of the head, away from the point where the weld was made in the backing ring that attached the head to the shell (Fig. 6). Also a number of small fine cracks were observed running under the backing ring. Machining away the unfused portion of the backing ring revealed that the major cracks extended to the circumferential weld. The microetch showed that the numerous fine cracks stopped a slight distance from the weld just outside the heat-affected zone. Figure 7 shows a cross section of the fine cracks in the early stage of their formation taken from this sample of steel. Figure 8 is the same as the Fig. 7 except that it has been etched to show the intergranular type of cracking and the branching cracks typical of stress-corrosion cracking. Figure 9 shows one of the typical type of branching network cracking that is found upon surface sectioning the crack in this type of steel from this service. Figure 10 illustrates the magnetic powder test indication which is found from a section of a head that had failed in service by apparent cracking in another area away

Fig. 7 Cross section of crack in early stage of formation

from the area where this sample was taken. Figure 11 shows the backing strip partly removed and the cracking indications after a 1:1 hydrochloric acid etch. Note the cracking indications in the areas of arc strike at bottom of picture of specimen. Figure 12

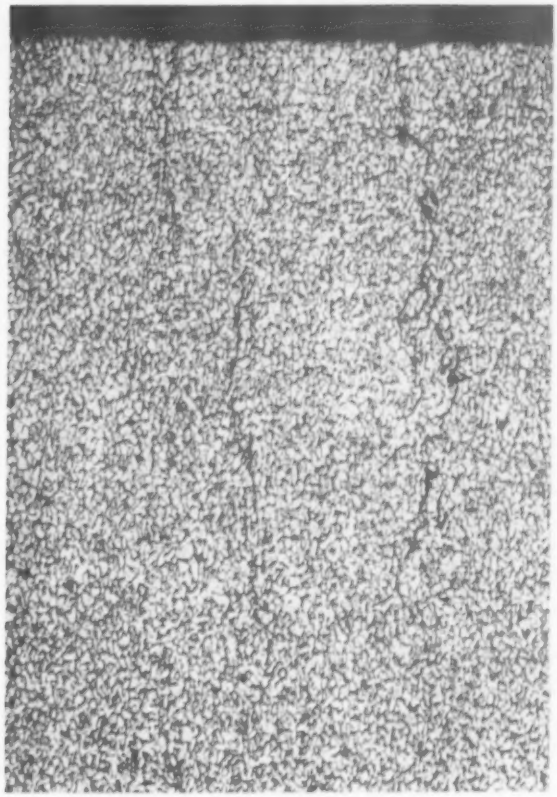

Fig. 8 Nital etched area shown in Fig. 7

Fig. 9 Surface section of crack area from cold-formed head from anhydrous ammonia service

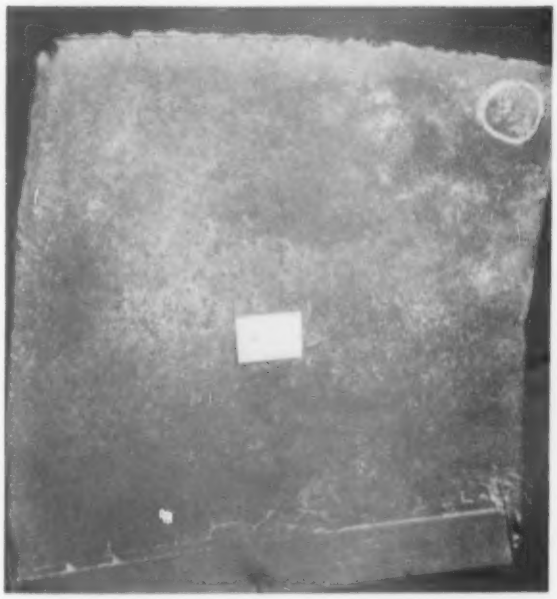

Fig. 10 Typical magnetic powder test indication of inside of failed head from anhydrous ammonia tank

Fig. 11 Section from Fig. 10—etched

Fig. 12 Etched section from elliptical cold-formed head

shows a section of a 60-in. cold-formed hemispherical head with a $2^1/_2$-in. straight flange that had failed in agricultural ammonia service. This is a typical deep-etched section from this cold-formed head. Attention is called again to the fact that the majority of the cracking stops at the edges of the heat-affected zone. This, of course, is not necessarily true of cracks which have penetrated through to the tension side of the head due to vapor pressure forces. This indicates, however, a metallurgical condition in the steel conducive to the stress-corrosion cracking rather than the welding stresses. This is not to say, however, that under certain conditions of welding and certain conditions of environment in the agricultural ammonia service that the welds would not be subject to stress-corrosion cracking. The author knows of only three cases of weld failure that have been defined as stress-corrosion cracking. Figure 13 is an example of this occuring. The head section shown herein, however, was not removed because of cracking in the weld, but of the cracking in the head as reported on the other case histories. However, magnetic powder test indications shown on the tack welds in the backing bar to the head, indicates the typical mud flat pattern of cracking caused by stress corrosion as well as the cracks that exist in the heads at the points of these tacks.

Conclusions

Anhydrous ammonia, as stored and distributed for agricultural use, has the ability to produce stress corrosion cracking under certain impurity levels. These levels have not been established to date, nor has the corrodent impurity been identified. Attention is called to the fact that references in literature indicate that any ionizing material such as ammonia, water or other substances can be considered corrosive under high states of triaxial stress.

Pressure vessels built for service in agricultural ammonia should, as a minimum, be built using heads of low-residual stress prior to their being attached to the vessel. By this, it is meant, that the heads, if cold formed, should be stress relieved after forming; if hot formed, indications are that the stress level is low enough to prevent failure under most conditions. However, in the author's opinion, stress relieving of the container as a whole, should be considered the minimum-quality pressure vessel acceptable for such service. Indications shown in the foregoing are that the contaminants can possibly concentrate to such a point in the vessel as to produce stress-corrosion cracking in the welds. Relief from this would be obtained for the future safety of the vessel by complete stress relief of the vessel after construction.

From the foregoing, it is noted that these leaks appear as very small cracks on the outside surface of the container. If the vessel has been painted these can have the appearance of a pinhole, truly leaking through a pinhole in the paint itself. The practice as recommended by certain people in the metal industry of peening of pinholes should not be done on tanks containing liquefied compressed gases. From the illustration in Fig. 14, it is shown that the supposed pinhole leak could well be the point of origin on the outside of one of the cracks on the inside; a sudden blow applied to this area would cause ultimate failure and, with the energy of the liquefied compressed gas, result in a violent explosion.

It is concluded also that there is a broad need for further research into the phenomena of stress-corrosion cracking, and into the conditions of structural materials both metallurgically and chemically contributing to their susceptibility to the phenomena known as stress-corrosion cracking.

Fig. 13 Magnetic powder test indication of stress-corrosion cracking in tack welds

Fig. 14 Some vessels have failed in this manner after a supposed pinhole was peened

Acknowledgments

The author is indebted to the entire Research Committee of the Agricultural Ammonia Institute for contributions made to the preparation of this paper during the past year. The author is also indebted to the metallurgical research department of the A. O. Smith Corp. for the use of illustrations from a report that was made by that department.

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Various techniques employed in the application of the inert-gas tungsten-arc process to the welding of titanium outside of atmosphere-controlled chambers are compared and discussed

WELDING OF TITANIUM

BY E. F. GORMAN

Fig. 1 Laboratory inert-gas tungsten-arc manual set-up for welding titanium outside of chambers

Introduction

Since its introduction as a commercial metal approximately 7 years ago, titanium has been adapted to a great number of uses. In the aircraft industry, it has already been used for engine firewalls, exhaust shrouds, jet-engine compressor housings, and for fuselage skins and stiffeners. In the chemical industry, as another example, titanium has been used for piping, the lining of tanks, and valves. In order to be generally useful, however, titanium must be fabricated into finished assemblies. This means that various methods of joining are involved—methods such as riveting, brazing and welding. Until recently, the welding of titanium has proved troublesome and, in many cases, unsatisfactory. For this reason, the use of titanium has been largely limited to parts which could be forged or riveted together.

Early attempts to weld titanium with conventional procedures gave very poor results. Subsequently, much of the original development of titanium welding data was carried out in chambers where atmospheric air had been replaced by either argon or helium. Unfortunately, this early work led to the misconception

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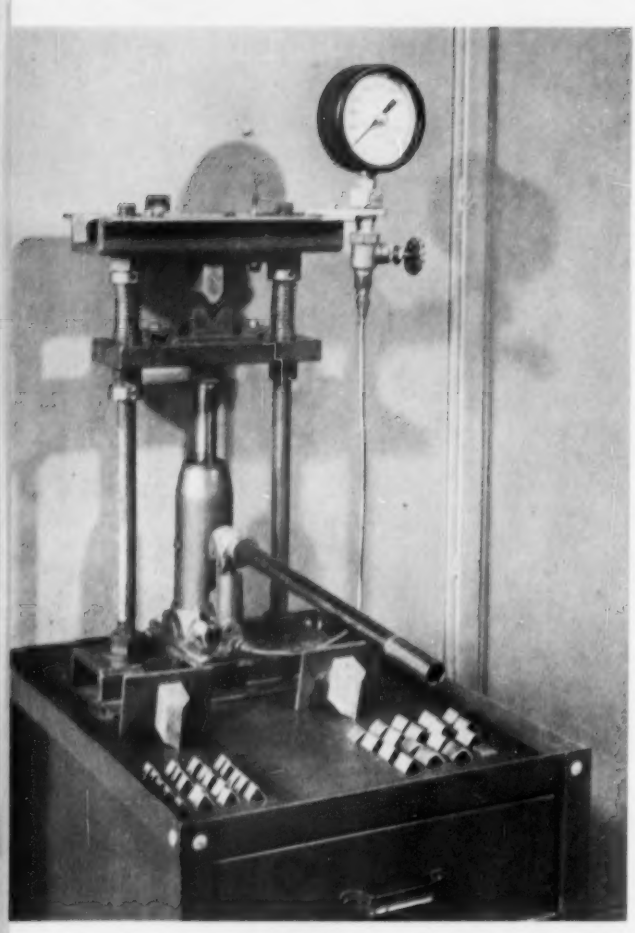


Fig. 2 Bend test equipment

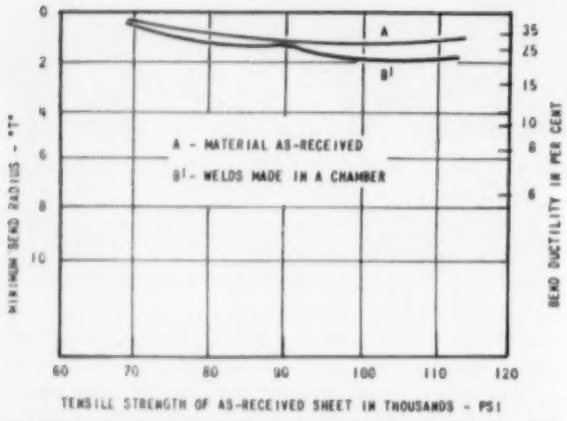

A
B¹
A - MATERIAL AS-RECEIVED
B¹- WELDS MADE IN A CHAMBER
MINIMUM BEND RADIUS - "T"
BEND DUCTILITY IN PER CENT
TENSILE STRENGTH OF AS-RECEIVED SHEET IN THOUSANDS - PSI

Fig. 3 Comparison between the ductilities of as-received material and welds made within a chamber

on the part of many that welding in a chamber is the only way to obtain good results. If, however, titanium is to achieve general acceptance as a major engineering metal, practical welding techniques must be developed which will eliminate the need for chambers. Recognizing this, our Laboratory investigated the application of the inert-gas tungsten-arc process to the welding of titanium outside of a chamber. In this paper, attention is directed to the results of this investigation which was made with particular emphasis on the inert-gas tungsten-arc welding of commercially pure titanium. The effects of various welding techniques are compared, and a practical test criterion for evaluating weld results is described. A final intent of this paper is also to report on the recent application of this information to the welding of titanium alloys.

Welding of Commercially Pure Titanium

Laboratory Test Program

To simplify any final interpretation of results, the Laboratory initially concentrated on the inert-gas tungsten-arc welding of commercially pure titanium. In this manner, additional complications, such as the metallurgical effects of alloys, were avoided. Samples of 0.050 in.-thick sheet were used for these tests. The samples were selected, according to tensile strength, from different heats and included materials ranging from 69,000 psi up to 113,000 psi tensile strength. Furthermore, the samples were obtained from three different manufacturers. The test samples were selected in this manner so that any variations in weld behavior caused by differences in quantities of residual elements could be averaged out. A general representation of weld results could, therefore, be determined that would reflect commercial practice. In view of the unusual behavior of titanium, however, it was necessary to establish a reliable criterion for evaluating weld results before undertaking a general welding program.

Test Criterion

Preliminary tests showed that porosity is not generally encountered in welding commercially pure titanium, and it was concluded that weld soundness could not be used as a measure of results. It was also found that weld discoloration was an unreliable guide for evaluating the effects of welding, since discoloration often represented slight contamination of the weld

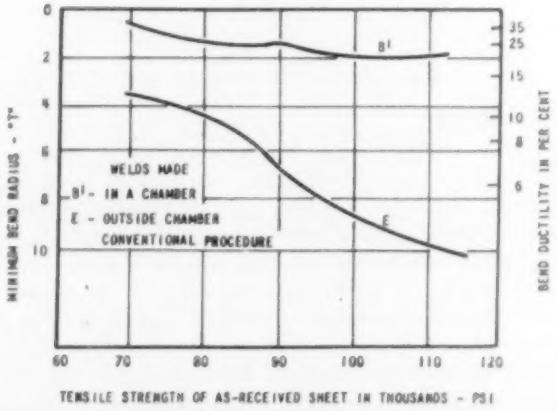


Fig. 4 Effect of conventional inert-gas tungsten-arc welding on ductility (Curve E)

surface. Tensile samples generally broke in the base metal and proved of no value in establishing a standard. Weld ductility, however, varied over a wide range and was, therefore, established as the best criterion for determining weld results.

Bend ductility was determined by bending the sample through an angle of 105 deg around a measured radius. The minimum radius of bending without weld failure was reported in terms of the ratio T, which is the ratio of the bend radius to the thickness of the sheet. As an example, a $1T$ minimum bend radius means that the sharpest radius around which the material could be bent was equal to the thickness of the material. Figure 2 shows the apparatus used to make these bend tests. In this illustration, three male dies of various radii can be seen—one clamped in place to the top cross piece of the jig, and the other two lying on the table. One can also see two separate collections of small samples, which have been bend-tested.

Weld Tests

From the beginning, atmospheric contamination was known to have decided effects upon the tensile strength and ductility of titanium. Other investigators had already pointed out how relatively small additions of oxygen and nitrogen produced greatly increased tensile strengths in this material, and correspondingly, a decrease in ductility. Since these gases are the major components of air, it was necessary to avoid, as completely as possible, exposure of heated titanium to the atmosphere.

Initially, the extent of the problem associated with the successful welding of titanium was determined by comparing the bend ductilities of welds obtained in a chamber with welds obtained using conventional procedures (normal inert-gas tungsten-arc welding techniques) outside of a chamber. The chamber was purged with argon, and the purge was continued during the welding operation. In addition, a separate flow of argon was maintained through the tungsten-arc torch which was used to make the welds.

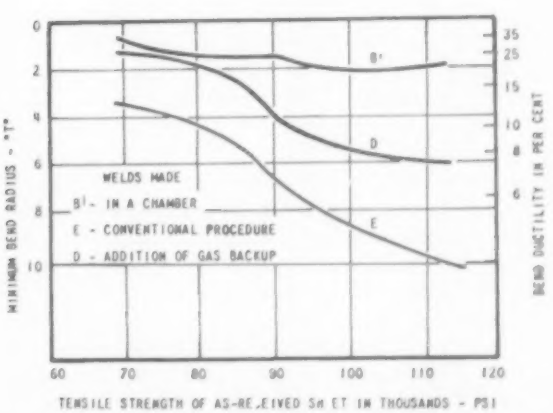


Fig. 5 Effect of argon back-up on the ductility of welds made outside a chamber (Curve D)

An investigation was then made to determine techniques that would give improved results over those obtained with conventional welding procedures. The approach was to obtain the desired results by minimizing the amount of atmospheric contamination encountered during welding. Logically then, it was necessary to obtain better inert-gas shielding of the weld; and if possible, to further reduce the opportunity for atmospheric contamination by reducing the time during which the titanium could actively absorb these contaminants.

Weld Test Results

The minimum bend radii for the base material, chamber welds and nonchamber welds have been plotted against the tensile strength of the base material in the following five sets of curves shown as Figs. 3 through 7. In each set, the coordinates are (1) the minimum bend radius T of the as-received, or welded samples, and (2) the tensile strength of the as-received material.

In Fig. 3, curve A represents the base material, and B' represents the ductility of the chamber welds. It may be observed that even under ideal conditions, a slight loss of ductility occurs.

In Fig. 4, using curve B' from Fig. 3 for reference, the results obtained with conventional procedures are illustrated by curve E. The great disparity of ductility between the two curves is clear proof that conventional

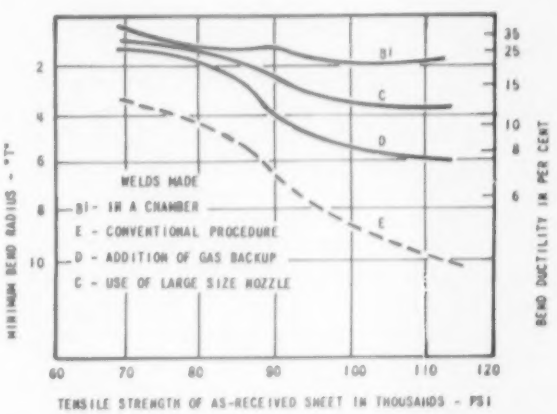


Fig. 6 Additive effect of large-size nozzles and argon back-up on the ductility of welds made outside a chamber (Curve C)

procedures are unsatisfactory for the welding of titanium.

In Fig. 5, curve D (added to those of Fig. 4) demonstrates the improvement which occurs when argon backing is used with otherwise conventional procedures. This curve indicates that the protection given by gas backing is a basic requirement when welding titanium. With this additional protection, the ductilities of welds made in low-strength, high-purity titanium closely approximate the ductilities of chamber welds. In the case of high-strength materials (approximately 90,000 psi and higher), ductility is still quite low.

In Fig. 6, curve C (added to those in Fig. 5) is a

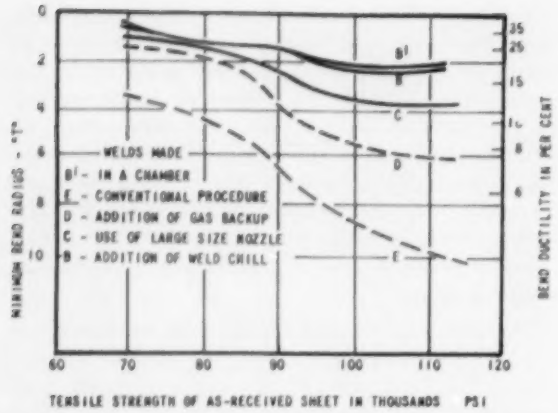

WELDS MADE
B' - IN A CHAMBER
E - CONVENTIONAL PROCEDURE
D - ADDITION OF GAS BACKUP
C - USE OF LARGE SIZE NOZZLE
B - ADDITION OF WELD CHILL
MINIMUM BEND RADIUS - "T"
BEND DUCTILITY IN PER CENT
TENSILE STRENGTH OF AS-RECEIVED SHEET IN THOUSANDS PSI

Fig. 7 Combined effect of weld chill, large-size nozzles, and argon back-up on the ductility of welds made outside a chamber (Curve B)

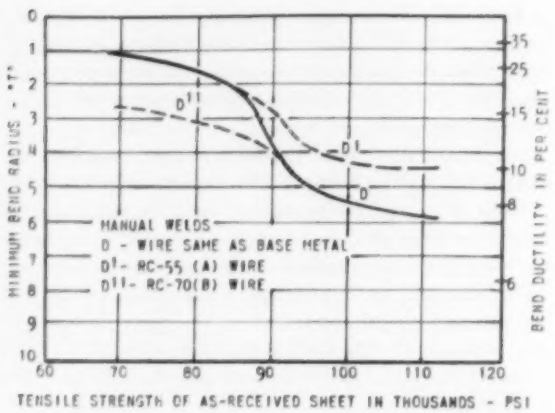

MANUAL WELDS
D - WIRE SAME AS BASE METAL
D' - RC-55 (A) WIRE
D'' - RC-70(B) WIRE
MINIMUM BEND RADIUS - "T"
BEND DUCTILITY IN PER CENT
TENSILE STRENGTH OF AS-RECEIVED SHEET IN THOUSANDS - PSI

Fig. 8 Effect of filler-wire purity on titanium weld ductility

measure of the combined improvements of using large diameter nozzles and argon backing as compared to conventional techniques. With large nozzles of approximately $^3/_4$ in. ID, good results are obtained with argon flow rates as low as 10 cfh. Tests with helium as the shielding gas showed that equivalent results could be obtained but required flow rates of about 30 cfh. From these tests, it was possible to conclude that argon is the most economical shielding gas for welding titanium.

The large nozzle technique is also effective for fillet welding. This is made possible by extending the electrode a distance of about $^1/_2$ in. beyond the large-diameter nozzle. With this arrangement, better shielding can be obtained than with small-diameter nozzles operating close to the joint.

In Fig. 7, a final measure of improvement is obtained by applying weld chill together with a large-size nozzle and argon backing. This is illustrated by curve *B* which is added to those in Fig. 6 In this case, a grooved, water-cooled copper chill bar was used; and the titanium sheet was tightly clamped against this chill bar to ensure maximum chilling. (The chill bar was drilled to provide a means of obtaining argon backup.) Comparing curves *B* and *B'*, it can be seen that essentially all of the ductility available in titanium welds had been obtained by the improved procedures. Curve *B* shows that the use of welding chambers is not always necessary.

In summarizing the results shown by the curves in Fig. 7, the most important requirement for obtaining good ductility in titanium welds is to ensure good argon-backing protection in addition to the primary argon shield on top of the weld. In this way, commercially pure titanium with tensile strengths less than about 90,000 psi will have adequate ductility for most applications. Additional precautions are necessary for higher strength, commercially pure titanium. For these materials, weld-bend ductilities essentially equivalent to that obtained in a chamber can also be obtained by the use of large-diameter nozzles and weld chill.

The manual welding setup used during the welding of titanium outside of the chamber is shown in the lead photo, Fig. 1. In this illustration, the operator is using a tungsten-arc torch and a large-diameter nozzle to prepare a flat butt weld in the titanium sheet. The sheet is supported in a jig, and the hold-down bars are forcing the sheet tightly against the chill bar. Argon is being used to protect the weld both through the torch and also through holes drilled in the chill bar. The filler wire held in the operator's left hand was obtained by shearing strips from the base metal.

Other Factors

Other factors are involved in the welding of commercially pure titanium. They include considerations affecting the choice of filler wire, the use of elongated nozzles, and techniques for welding where it is impractical to use a chill bar.

As shown in Fig. 8, the use of filler wire with a purity different from that of the base metal affects final weld ductility. Curve *D* in Fig. 8 is the same as curve *D* in Figs. 4 through 7. Curve *D'* shows the improvement in weld ductility that can be obtained when welding high-strength titanium with a high-purity filler wire. Curve *D"* shows the reverse effects obtained when using a low-purity wire.

Elongated nozzles or cups were briefly investigated, and their use restricted the freedom of the operator to position his welding torch as desired. Such nozzles may, however, be necessary to produce good weld ductility for mechanized welding, where the speed is sufficiently high so that molten or hot titanium would be subjected to the atmosphere if round nozzles were used.

An experiment involving an elongated cup is worthy of mention, since it concerns weld discoloration as a basis for determining whether a weld is good or poor. Two welds were compared—the first weld having been made with a large nozzle and the second weld with an elongated cup. The first weld had some discoloration but was found to have good ductility. The second

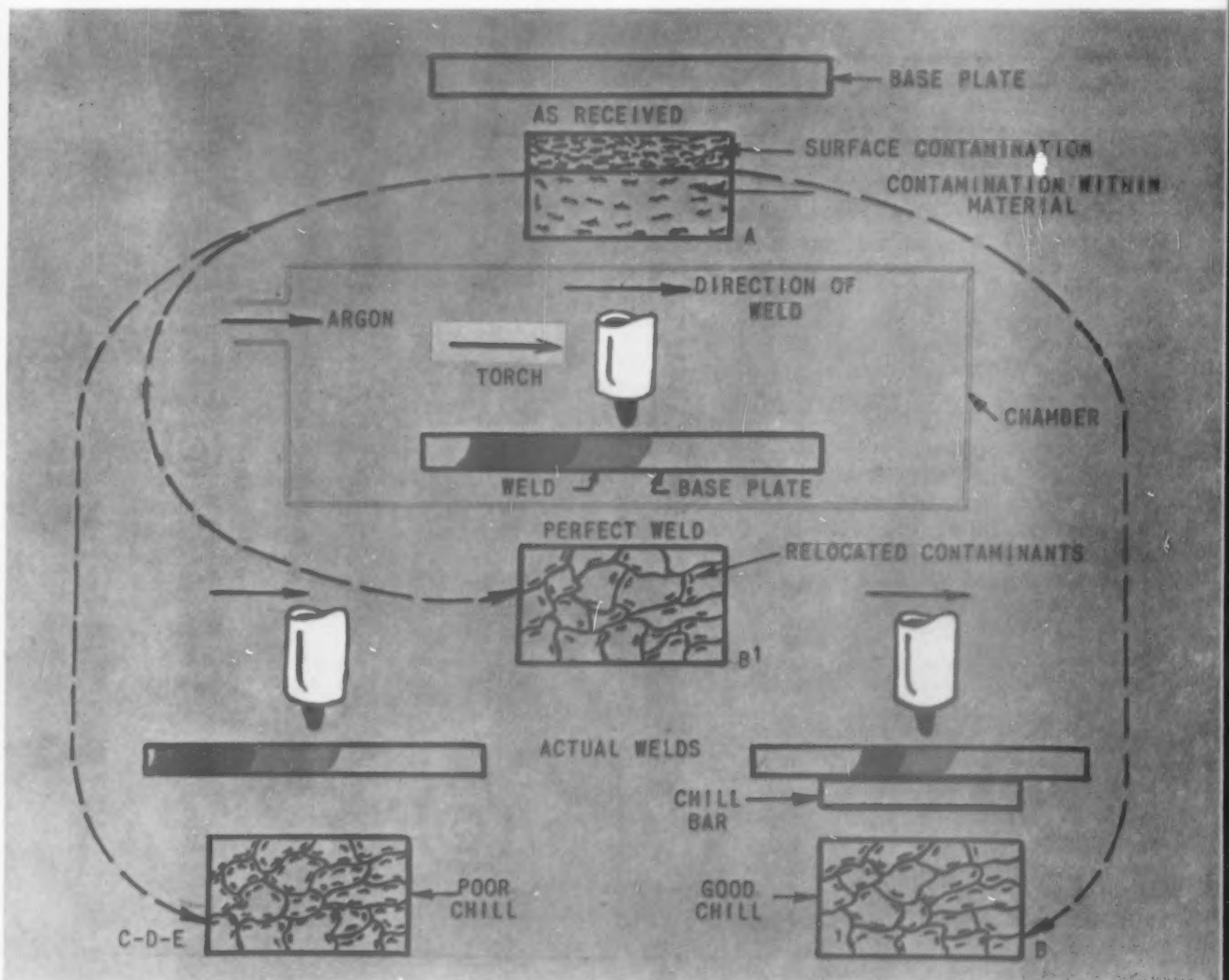
weld was relatively clean (without discoloration) but had substantially less ductility than the first sample. It was later determined the elongated cup was defective in that it provided good shielding of the postweld surfaces but at the expense of the weld puddle. Contaminants, which had been picked up at the weld puddle were completely absorbed leaving no trace. This experiment illustrates the unreliability of weld discoloration for use as a criterion for judging the extent of weld contamination or loss of weld ductility.

As noted previously, weld chill is advantageous when welding the high-strength titanium sheet. However, when the joint design is such that the use of a chill bar is impractical, there are certain techniques which will be helpful in obtaining good welding results. These techniques are primarily based upon the interruption of the welding cycle to prevent excessive heat buildup in the weldment. There are several variations which can be used: backstepping, stopping the weld every inch or so to let it cool, or combinations of the two. These methods were found to be quite effective for the welding of tube tee and tube cluster joints, where weld chill would have been difficult to accomplish.

Causes of Loss in Weld Ductility

Having described the various techniques that are effective toward obtaining good weld ductility in commercially pure titanium, this question arises: "What are the reasons for loss in weld ductility?" Some insight into the reasons for loss in weld ductility is shown in Fig. 9. This is a schematic representation of what happens to commercially pure titanium when a weld is formed. It shows, in a graphic way (not to be taken too literally), what happens regarding grain growth and contamination. The starting point shown at the top of the illustration is the base plate as-received. In the idealized cross section (labeled "A") just below the base plate, a certain amount of contamination is already present. These contaminants include carbon, iron,

Fig. 9 Grain growth and contamination in titanium welds



oxygen and nitrogen. The material as-received is generally in the hot-worked and annealed condition, with small grains and with the contaminants well-dispersed throughout the structure. The ductility is high as illustrated by curve *A* in Fig. 3.

If the material is welded in an argon-atmosphere chamber, no additional oxygen and nitrogen contamination can occur. The end product is the idealized cross section in the center of Fig. 9 and identified as B′. This cross section has very large grains and a relocation or dispersion of contamination along grain boundaries. It is believed that the relocation of the contaminants present in the original base metal is the major reason for the slight losses in ductility encountered in chamber welds. These losses are represented by the spread between curves *A* and *B′* in Fig. 3. Although the actual relocation of contaminants in titanium welds is not clearly understood, contamination is shown concentrated at the grain boundaries to suggest the method of failure in titanium welds. It has been observed that embrittled welds in titanium will fail by separation of the grains from each other.

Section C-D-E in Fig. 9 depicts the results of a weld made with conventional procedures. As shown, a great deal of contamination has been absorbed and is located at the large grain boundaries. (A serious loss of ductility has occurred as indicated by the curves *C*, *D*, and *E* in Fig. 7.)

A third representation in Fig. 9 is section B, which illustrates a weld made using the improved techniques previously described. These include weld chill, a large nozzle, and argon backing. Section B is essentially equivalent to that shown in section B′. The ductility of the welds, which these sections represent, is also comparable as evidenced by the close proximity of curves *B* and *B′* in Fig. 7. The grains are again large, and the contaminants are located at the grain boundaries. There is no appreciable increase in the amount of contamination as compared to the chamber weld represented by section B′.

Referring to both of the representations (sections B and C-D-E) showing the process of welding outside of a chamber, one can observe the differences in the sizes of the molten weld puddle and postweld-heated area. As a consequence of using a chill bar, the sizes of both these areas are substantially reduced. In the case of the weld made with the chill bar, however, a large-diameter nozzle was also used because it provided argon protection for a proportionately larger area than that obtained with a smaller nozzle. The effect of using both the large nozzle and the chill bar for welding titanium is to increase the efficiency of the argon protection.

Contamination encountered during the exposure of heated titanium to air is a function of both time and temperature. By decreasing either or both the time and temperature to which the titanium is heated, contamination of titanium can be reduced to negligible amounts. Weld puddles are the most active areas of contaminant pickup and must be carefully protected. Heat-affected zones are also active areas of contaminant pickup but to a lesser extent. Heat-affected zones should be protected when they are at temperatures in excess of 1600° F. Below this temperature, however, the cooling times encountered in normal welding practice are too short for contamination to be absorbed in quantities sufficient to affect ductility noticeably. Should the heat-affected zones be exposed to air at temperatures ranging from about 1200° F up to 1600° F, some discoloration can be observed. However, it indicates the contamination of only a very thin surface layer and does not affect weld ductility.

Titanium Alloys

Welds in titanium alloys, using the best techniques which have been developed, are generally brittle. Many times the material cracks either in the jig or while being removed from the jig. Some alloys have been found responsive to heat treatment after welding. For example, welds made in a titanium alloy with 8% manganese have essentially no ductility. A postweld heat treatment at 1625° F in an argon atmosphere for $^1/_2$ hr followed by furnace cooling restores the weld ductility to a bend radius of better than 5*T*. While ductility is not completely restored by this heat treatment, it is considered sufficiently good for many applications. Another example is a titanium alloy containing 3% aluminum and $^1/_2$% manganese, which was also found to be responsive to postweld heat treatment. Heat treatment is obviously not a complete solution for improving weld ductility since such processing is often not practical on welded structures.

A better solution for obtaining ductile welds in titanium alloys would be the development of weldable alloys. The latest alloys suggested for this purpose contain (1) 6% aluminum and 4% vanadium, and (2) 5% aluminum and $2^1/_2$% tin. The welding of these materials is being actively investigated with the hope that practical techniques can be developed.

Conclusion

The foregoing material covers many factors involved in the inert-gas tungsten-arc welding of commercially pure titanium and titanium alloys. All work to date has been directed toward the development of practical and useful techniques which will permit welding outside of a chamber. In order to focus attention on the most significant developments, the following points are reiterated:

1. Using the best welding techniques (including argon backing, large-diameter nozzles, and weld chill), good bend ductility can be obtained in welds made in commercially pure titanium *outside of a chamber*.
2. The bend test is the *best criterion* for determining the extent of weld contamination.
3. The techniques developed for welding commercially pure titanium outside of a chamber also apply to the welding of titanium alloys.
4. It is generally necessary to heat-treat titanium alloys after welding in order to restore weld ductility.
5. It is not necessary to weld in an inert-gas chamber in order to obtain good welds in titanium.

OXYACETYLENE WELDING OF JET ENGINE PARTS

If you hear a noise that sounds like a great hand has pulled the cork from a giant champagne bottle in the sky, look up quickly. You may be able to witness the world's newest phenomenon—a jet plane breaking the sound barrier. That airplane, moving faster than the speed of sound, represents some of the greatest technical strides made within the last ten years.

Welding has advanced during those years. Many new techniques for joining dissimilar metals, welding heat-resistant alloys, and fabricating light, strong metals have been developed. But, the old stand-by—the oxyacetylene flame—has kept pace with these new developments.

Aero Trades Co., in Mineola, Long Island, uses oxyacetylene welding in the manufacture of jet engine manifolds. In the hands of an expert operator, the oxyacetylene torch is an essential member of the production team used by this manufacturer.

How the Manifolds Are Made

The first step in the production of these parts is to stamp each half from 0.064-in. thick aluminum sheet (see Fig. 1). The two halves are then spot-welded, semi-automatically, as shown in Fig. 2. The basic manifold piece is now beginning to show some indication of its final form.

After spot welding, the blanks are moved to a contour saw, where an operator cuts around the manifold,

Based on a story by Linde Air Products Co., New York, N. Y.

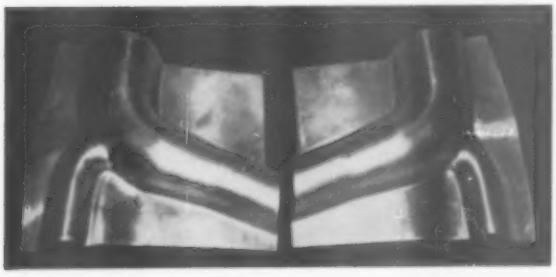


Fig. 1 The first step in making these manifolds is to stamp each half from aluminum sheet

Fig. 2 The halves are next spot welded semi-automatically and the basic shape of the part is formed

Fig. 3 Sawing the spot-welded manifold blanks to contour is the third step in their production

Fig. 4 In preparation for oxyacetylene welding, an operator paints the flanges with flux

leaving a slight flange (see Fig. 3). The parts are placed in a box and taken to the welding area. Here, oxyacetylene flames are used to make two longitudinal welds in the manifolds. The girth-welds are made with an inert-gas-tungsten-arc welding torch.

Welding the Manifolds

Before the weld is started, the flange which was left after the sawing operation is cleaned and painted with flux (see Fig. 4). The aluminum welding rod has also been coated with aluminum welding flux. Using a welding tip the same size as for a similar thickness of steel, the operator adjusts the flame to a small excess acetylene feather. Then, she carefully preheats the entire length of the joint, making sure not to overheat the manifold (see Fig. 5).

Fig. 5 After preheating, the operator makes a weld in the flanged aluminum sheet

Fig. 6 Here is the basic manifold after both longitudinal seams have been oxyacetylene welded

Fig. 7 Since the part is manufactured to close tolerance, it is placed in this jig for sawing

Oxyacetylene welding of aluminum is performed using a forehand technique. The operator keeps the torch at an angle of approximately 30° to the work. When she reaches the appendage, the work is repositioned on the jig, so that the direction of welding remains the same. At the completion of this joint, the piece is turned over and the other longitudinal weld is made in the same manner.

Upon completing both welds, the operator allows the manifold to cool slowly, and then cleans off all the flux. This cleaning must be done as soon as possible, since the flux is corrosive if left on aluminum. A manifold with the longitudinal welds completed and cleaned is shown in Fig. 6.

The next step in the production of these manifolds is performed on a cut-off saw. The welded piece is placed in a sizing jig, and all ends are cut to tolerance (see Fig. 7). When this operation is completed, the part is returned to the welding area for the addition of the tube ends by inert-gas tungsten-arc welding (see Fig. 8.)

After the inert-arc welding has been completed, the finished manifold is ground down on the inside to insure even gas flow in operation. It is next tested under water pressure of 125 psi to make certain that there is no leakage. The tested manifold component is matched to a mating piece, as shown in Fig. 9. These tests assure perfection and quality work—necessary in all jet engine production.

Fig. 8 Inert-gas tungsten-arc welding is used to join the small tube end to the appendage of the manifold

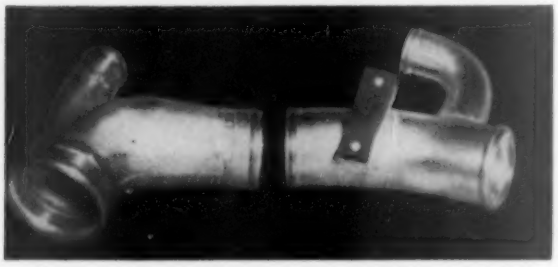


Fig. 9 After a water pressure test at 125 psi, the manifold is mated to an adjoining part

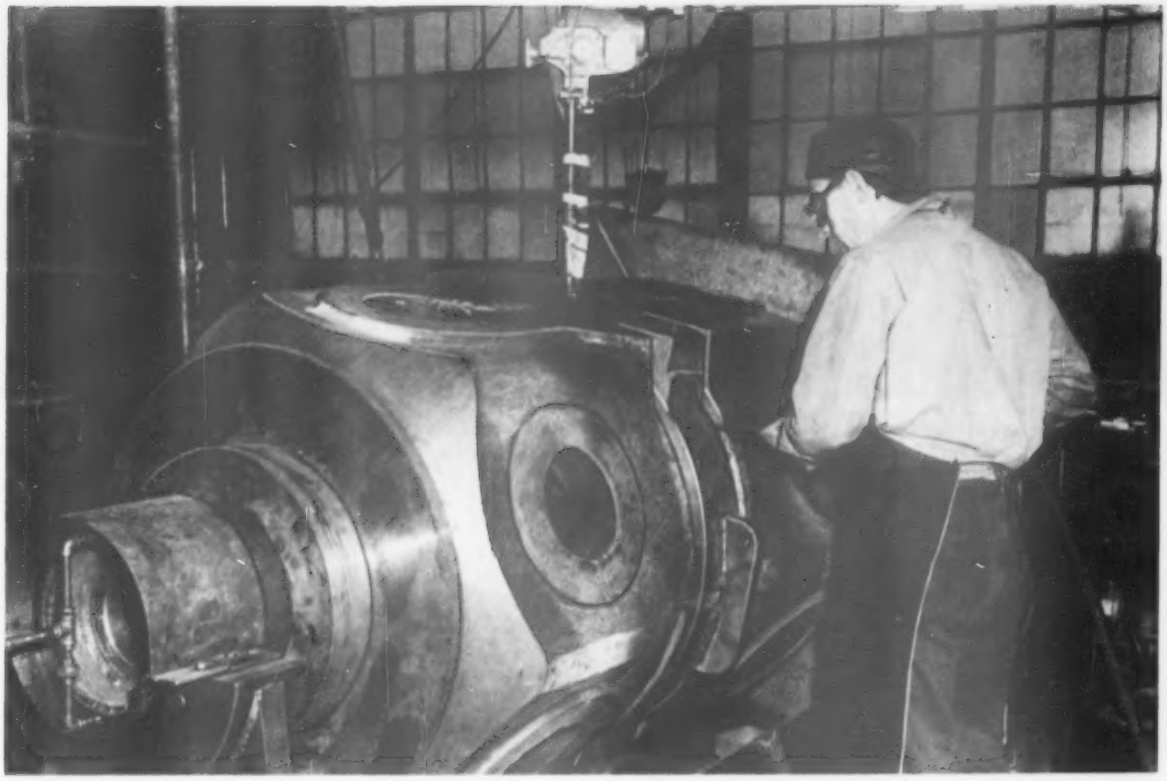


Fig. 1 This 12,000-lb compressor cylinder was cast in two sections which are submerged-arc welded together in this installation; automatic submerged-arc welding does the job faster and more economically than any other method previously used

SUBMERGED-ARC WELDING SOLVES AN "IMPOSSIBLE" ONE-PIECE CASTING JOB

BY WIRT F. BUCHANAN

Designs for a large compressor called for six-ton, double-walled cylinders with suction and exhaust chambers included in the jacket space. Casting seemed to be the only logical method of producing the part; yet it would have been practically impossible to cast the cylinder in a single piece.

A change in procedure simplified the production of these units at Cooper-Bessemer Corp., Grove City, Pa. It was decided to cast the cylinders in two sections (see Fig. 1) and to weld the halves together; however, welding methods used at first were slow and costly, and it was difficult to obtain sound welds. The problem was studied very carefully and the submerged-arc welding process was selected for the job. This modern, high-speed welding process cut 40 hours from the time needed to weld a single cylinder and produced welds of the highest quality. As a result, compressor cylinders are now being fabricated faster, stronger and more economically than ever before.

The giant cylinders are part of compressor units used in cross-country gas line pumping stations. They are 4 ft in diameter, approximately 7 ft long, develop 750 psi pressure and weigh 12,000 lb. Inside, each cylinder is divided into two chambers—an internal piston bore and a surrounding jacket which comprises the suction and exhaust compartments. The inner bore is 16 in. in diameter, the cylinder wall is $2^1/_2$ in. thick. The surrounding jacket is 42 in. in diameter and has a 3-in. thick shell.

The cast sections are made into a single unit by first welding the wall of the inner bore, and then the shell of the outer chamber. Weld preparation consists of machining the mating faces of the two castings, heating them to 450° F and aligning them in a rotating fixture. About 30 passes are made to complete the inner weld, and 55 to complete the outer weld. Average welding speed is 24 ipm.

Wirt F. Buchanan is Welding Superintendent, Cooper-Bessemer Corp., Grove City, Pa.

Fig. 2 Four sections make up the cylinder assembly; the inner bore of the two main sections extend beyond the outer shell to provide working room to make the inner weld; two semicircular pieces are then welded in the gap to complete the outer jacket

Edges of the outer shell are kept approximately 6 in. apart to provide working room while the inner bore is being welded. This space is filled by welding two semicircular pieces of the same thickness as the outer shell (seen in Fig. 2) in the opening. Two $^1/_4$- by 1-in. backing strips are also used in the final welding operation. Welding is done with a current of 575 amp dc, reverse polarity supplied by a rectifier.

After welding, the cylinders are ground, checked with a dye solution for imperfections and annealed. Completed compressor cylinders are smooth, sound, efficient units (see Fig. 3).

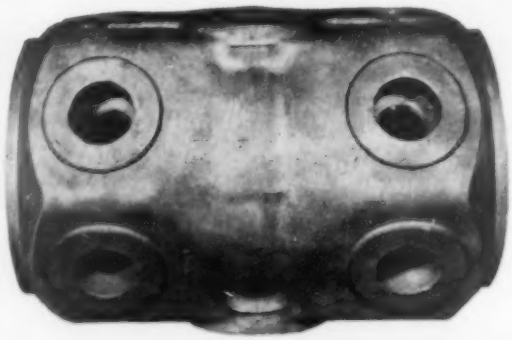


Fig. 3 The completed cylinder after being ground, dye-checked and annealed

TUNGSTEN-ARC WELDING SPEEDS PRODUCTION OF CORROSION-RESISTANT CABLE SUPPORTS

Aluminum and steel support systems for power cables and piping of all types (see Fig. 1) are being produced at new top speeds and high quality with inert-gas tungsten-arc welding. The Husky Products Corp., Cincinnati, Ohio, manufactures cable carriers made of both weight-saving, nonmagnetic aluminum, and hot-dipped galvanized steel. Porosity-free inert-arc welds take only 15 sec to complete, and require no finishing.

Both the aluminum and steel systems are corrosion resistant, and require no maintenance under normal conditions. The cable carriers are rigid, have high load capacities and can be placed on supports up to

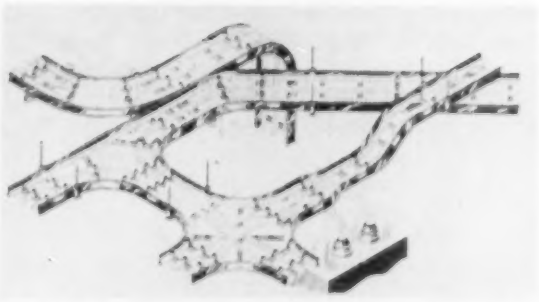


Fig. 1 By using inert-gas tungsten-arc welding, these sturdy, lightweight cable carriers are being fabricated at new high speeds; this is a sketch of a typical installation

Based on a story by the Linde Air Products Co., New York, N. Y.

Fig. 2 Crosspieces are set in holes punched in the curved members of this support cross, and inert-gas tungsten-arc welded in place

Fig. 3 Inert-gas tungsten-arc welding a long cable rack section; completed welds need no finishing or postweld treatment

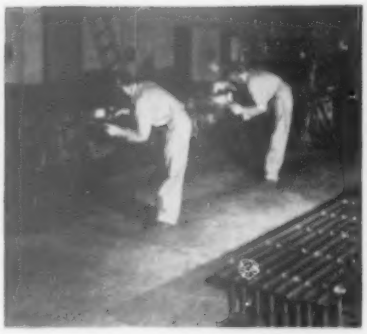


Fig. 4 Each weld requires only 15 sec to complete; this particular cable rack is 24 ft long; jig used is simply an 8-in. pipe with clamps welded on

12 ft apart. This reduces the number of hangers and brackets needed, and saves valuable building space.

Cable carriers are fabricated in sections of different lengths and shapes. Small aluminum sections weigh as little as $4\frac{1}{2}$ lb, and sections 20 ft long weigh only 39 lb. The basic design shown in Figs. 2, 3 and 4 consists of a series of bar-like crosspieces set in punched holes and welded between the two parallel strips. The inert-arc welded supports are neat, and cables and tubings are readily accessible after installation. Supports are made in standard pieces and in tailored sections, depending upon installation needs.

CAST WELDMENTS HELP TO PRODUCE SPECIALIZED UNITS

The field of cast weldments has been gaining a great deal of recognition in recent years. When considerations of weight, design, and cost make it practically impossible to produce a piece as a single quality casting, foundrymen turn to cast weldment design. The unit is divided into castable segments, and these cast segments are welded together.

The cast weldment process is being used in the production of many specialized units. For example, screen frames for the Ahlfors upflow vibratory pulp screen are now being made in this manner (see Fig. 1). Originally of bolted construction requiring expensive machine work and fastenings, the frames are now of welded construction and offer the simplicity and quality of a well-designed integral casting; greater durability and economy have been achieved.

This pulp screen is classified as a flat type screen with a further development, however, of pushing the flow of pulp stock upward through the screen plates. This is done since in pulp stock the natural tendency of the lighter and finer fibers is to rise; the heavier dirt and undesirable fibers tend to drift downward.

This upward screening has two advantages. First, the dirt and pitch that collect in the screen slots can be blown back into the rejected stock flow by overhead showers. This increases the cleanliness of output. Second, because of the higher consistency of the screened stock, the screening requires less diluting water and reduces the amount of pulp thickening equipment required later on.

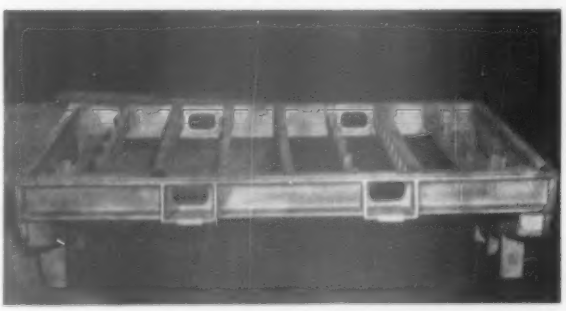


Fig. 1 Typical application of cast weldment design is shown in the construction of this frame for a vibratory pulp screen

The heavy load of wet pulp, pulsated by the diaphragm, exerts an intense dynamic load on the frame. The frame is composed of chromium-nickel stainless steel end castings and side rails; the side rails are held together by seven extra heavy stainless steel cross bars which serve as supports for the screen plates. The frame is bolted to the flat top of a vibration dampener at the machined base of the end castings.

The cast weldments are heat treated and straightened before welding into the assembly. A jig is employed to insure proper positioning of the cast weldments. A stress-relieving heat treatment, followed by a careful dimensional check, insure that the unit is ready for final machining to the close tolerances required.

Based on a story by the Electric Steel Foundry Co., Portland, Ore.

SPOT WELD "HITS SPOT" IN MANUFACTURE OF AIRCRAFT

BY FRANK PEDROJA, JR.

Resistance welding was come upon by Professor Elihu Thomson while he was experimenting with a spark coil at a Philadelphia laboratory in 1885.

Its use spread rapidly in industry and it was adopted early in aircraft production (a spot-welded stainless steel airplane was produced in 1929). Widely used in the aircraft industry today, spot welding is a major departmental operation at Beech Aircraft.

The aircraft industry has been attracted particularly to spot welding because it saves weight, the cost of production is decreased, the welded surface is left smooth and the method is a great time-saver over other types of welding.

A spot weld has great shear strength (which makes it invaluable in specific cases), important static and fatigue strength and unusual corrosion resistance.

Restricted at first to a few light metals, today both ferrous and nonferrous metals are being spot welded successfully.

In our plants at Wichita and Herington many nonstructural steel, aluminum and magnesium pieces are spot welded partly or entirely. The list of items includes cabin doors and window frames, bulkheads for fuel tanks, control surfaces and numerous subassembly pieces (see Fig. 1).

Welders must measure their efforts against three factors: (1) the amount of electric current, (2) the resistance factor of the materials being welded and (3) the length of time of the welding action.

Meticulous checking of each welding machine and careful preparation of the materials to be welded are part of our daily routine.

In addition to a daily surface resistance test made by a quality control representative, throughout the day, as each different welding job is begun, the operators bring sample strips of the materials which they are welding for individual checks.

Three separate checks are made: (1) surface cleanliness of the material is measured on an electrical resistance tester; (2) shear strength is measured on a tensile test machine (see Fig. 2); and (3) a penetration check is made by sawing the spot weld in two and examining the fused area under powerful magnifying glasses. The penetration and shear strength must be

Frank Pedroja, Jr. is associated with Beech Aircraft Corp., Wichita, Kan.

Fig. 1 Spot welding a landing gear door

Fig. 2 Shear strength of spot-welded aluminum specimens is being measured on a tensile-test machine

Fig. 3 Basket of ailerons being washed in preparation for spot welding

Fig. 4 Fins for jettisonable jet fuel tanks begin a long ride through a mechanical etcher and dryer in being readied for spot welding

just right. Too much penetration will cause a tendency to crack; too little will not withstand the required shear test.

Because spot welding demands spotless materials and a completely conductive surface, metal pieces which are to be spot welded are cleaned thoroughly and etched before they are welded (see Fig. 3).

A hoist crane carries and dips baskets of parts into six large tanks for both hot and cold baths. The first dip removes oil, dirt and grease. In successive dips the parts are rinsed, etched in acid solutions to remove the nonconductive layer of aluminum oxide and rinsed again to arrest the etching action.

Two to five minutes in a steam dryer prepare the parts for spot welding. Dryer operators wear rubber gloves when they handle the parts in order to keep them as clean as possible.

For some parts, which have been previously heat treated, the process of cleaning and etching is entirely mechanical. On a conveyor, they are carried through two long tunnels where they are sprayed, dipped and steamed (see Fig. 4). Workers feed the parts into the tunnels and remove them from the conveyor after they have been cleaned, etched and dried in one operation.

Spot welding today is a carefully planned, precisely carried out part of the production of both commercial and military aircraft. A safer, lighter, sleeker airplane is being made because of it.

STUD WELDING SIMPLIFIES FASTENING OF STEEL LINER PLATES

Steel liner plates in huge rotary tumbling barrels made by N. Ransohoff, Inc., Hamilton, Ohio, must be easily replaceable but at the same time they must be secured so that they can withstand prolonged punishment. They are in constant jarring contact with heavy castings being cleaned in a cascading bath of sharp cleaning stars and cleaning compound. For this and other rugged fastening jobs on its metal cleaning equipment, Ransohoff uses stud welding.

Each of four compartments in a tumbling barrel built recently by this company is lined with 20 separate re-

Fig. 1 This huge rotary tumbling barrel has 800 $^{3}/_{4}$-in.-diam studs, welded to the backs of the replaceable liner plates and used to secure the liners to the barrel proper

Based on a story by the Nelson Stud Welding Division, Gregory Industries, Inc., Lorain, Ohio.

Fig. 2 Threaded studs, $^3/_4$ in. diam, are being end welded with the portable stud welding gun to the backs of steel liner plates used in rotary tumbling barrels

placeable plates of $^3/_4$-in. steel, secured to the barrel by $^3/_4$-in.-diam. threaded studs end welded to the backs of the liner plates (see Figs. 1 and 2). The studs project through holes in the barrel and are fastened on the outside by nuts and griptight washers. Replacement of liners is thus simplified because the nuts can be reached easily and the studs cannot turn when nuts are removed. A total of 800 studs are used on this barrel.

In addition, stud welding improved design by leaving the faces of the liner plates, which touch the tumbled work, free of projections which would be present with other fastening methods. The surfaces remain uniform, without worn bolt heads, irregularities or soft spots.

In effect, the studs fulfill a further fastening function in connection with chilled steel bars which are inserted between the liner plates and are held in place by them. The bars project sufficiently to carry the work up the sides of the rotating barrel and create the cascading action.

INERT-GAS TUNGSTEN-ARC WELDING SPEEDS FABRICATION OF RAMPS

Inert-gas tungsten-arc welding is speeding production of the largest magnesium loading ramps ever constructed. These strong, lightweight, "piggy back" ramps were developed to make end loading of truck trailers on to railroad flat cars faster and easier. By using a team of eight ramps placed at different sections of the train, up to 200 trailers can be loaded or unloaded per hour.

Based on a story by the Linde Air Products Co., New York, N. Y.

Fig. 1 Ramps are built entirely of magnesium plate and extruded shapes; sections range in thickness from $^3/_{16}$ to $^1/_2$-in. Note the smooth, high quality welds

There are 2130 ft of sound, clean inert-arc welds in a single ramp. The entire unit is built of type FS-1 magnesium plate and extruded shapes, which range in thickness from $^3/_{16}$ to $^1/_2$ in. All sections are clamped and tack welded in position, then joined by either fillet or V-butt welds. Each ramp is postheated to 450° F in order to relieve any existing stress and then

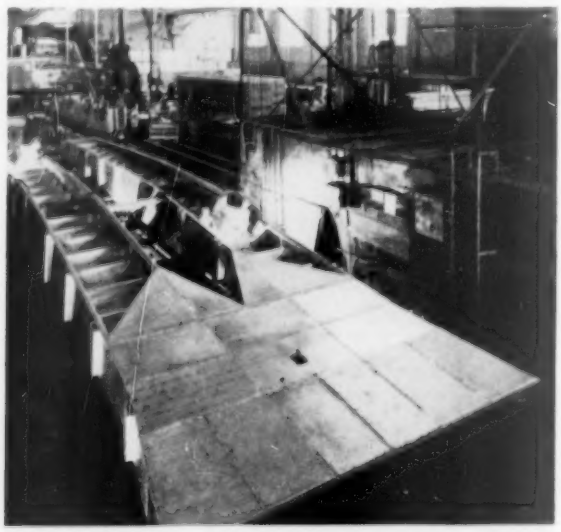


Fig. 2 When completed, this inert-gas tungsten-arc welded magnesium ramp will be capable of supporting loads up to 59,000 lb; it weighs about $^1/_5$ as much as an equal-size steel ramp

Fig. 3 Strong, lightweight inert-gas tungsten-arc welded magnesium trailer ramps have cut the time needed to load and unload railroad flat cars by more than half

cooled slowly. No weld finishing is necessary.

The ramps weigh only 4800 lb and move on rubber-tired wheels—they can be rolled into position by two men. A magnesium ramp can support loads up to 59,000 lb, or more than ten times its own weight. A single ramp, if made of steel, would be many times heavier and its usefulness as a portable unit would be lost.

INERT-GAS TUNGSTEN-ARC HARD SURFACING DOUBLES GRAIN HAMMER LIFE

The constant pounding of steel against grain in a hammer mill wears down the hammers quickly. A midwestern grain company now doubles the wearing life of its hammers by applying a layer of hard-surfacing material to the leading edge of the blade. And, the company has found that the best way to apply the metal is to use the argon-shielded tungsten arc.

In the first step of the hard-surfacing process, the operator inserts a metal rod through holes in a set of 30 hammers, separating the individual hammers with $^1/_2$-in. spacer rings. Both are tightened over the threaded end of the rod, holding the hammers in the correct position. The operator next removes rust and impurities from the edges of the hammers where the hard-facing material will be deposited. Once over the surface lightly with a grinder takes care of these preparations, and the hard surfacing is started.

Based on a story by the Linde Air Products Co., New York, N. Y.

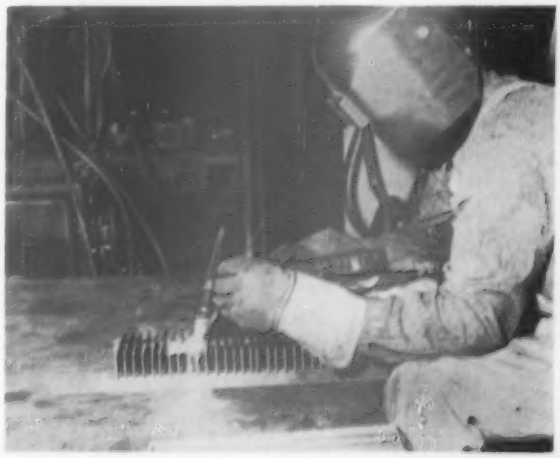


Fig. 1 A set of 30 grain hammers is hard-surfaced, using an inert-arc welding torch

An inert-arc welding torch is used to lay down a $^1/_8$-in. deposit of hard-surfacing rod along 3 in. of the leading edge of each hammer. The welding current is set at 1–5 amp., ACHF, and the argon flow is 20 cfh.

The inert-gas tungsten-arc method has two advantages over using an oxyacetylene torch—speed and quality. The time required to deposit the hard-surfacing metal is cut in half. Better quality is obtained because the argon shield prevents atmospheric contamination of the weld puddles. Welding speed is fast, keeping the heat-affected zone small and distortion to a minimum.

SILVER SOLDERING JOINS MONEL AND BRASS IN MARINE FABRICATION

Silver-soldering is essential in the manufacture of marine gasoline tanks at the Skyling Products Inc., plant at Deer Park, N. Y.

The tanks are fabricated from 0.037-in. thick Monel, which is used for its high corrosion-resisting properties. Once the Monel has been cut from sheet stock, the flat metal is bent and the seam welded into cylindrical shape. Then the ends are seam welded in place.

Next, several brass fittings are silver soldered to the tank. The boat's fuel line and plugs are connected to these fittings. The silver-soldering process is used because it gives an especially strong bond on sheet metal of 0.062 in. or less. An inferior bond could develop into a leak, which could result in fire, or stalling while at sea and far from help. With silver soldering there is no danger of this kind, no matter how much the boat engine vibrates or how rough the water.

Each fitting is set in its proper hole in the cylinder. The fitting is then painted with flux and preheated until it begins to sweat. Using the solder, the fitting and adjacent part of the tank are tinned and silver-soldered together, giving a neat, strong, and corrosion-resistant bond. No additional finishing is needed.

The total time for the whole process is less than 3 min. for the 3-in. fitting.

Based on a story by the Linde Air Products Co., New York, N. Y.

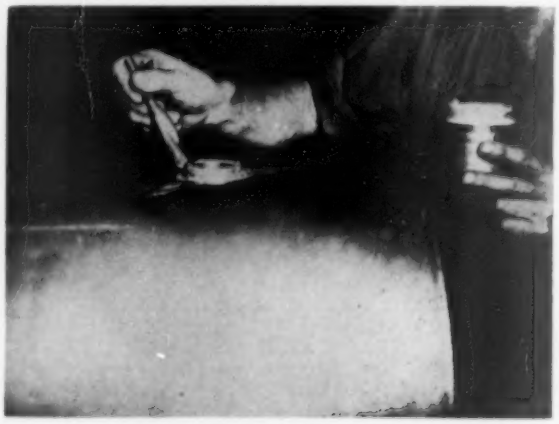


Fig. 2 The brass fittings are set into holes in the Monel tank. After coating with flux the fitting is ready to be preheated and soldered

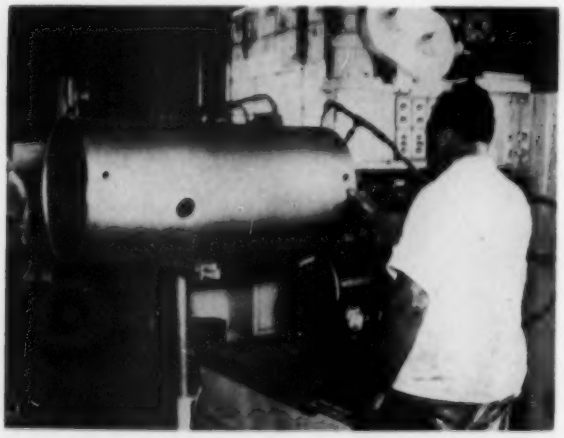


Fig. 1 Before the fittings are silver soldered, the ends are machine welded into these marine gasoline tanks. When they are completed each tank will hold 40 gal

Fig. 3 After the preparation and heating the solder is applied to the hot metal. The result of this operation is a strong bond that needs no further finishing

Society News

AWS Fall Meeting Technical Program Set

Fifty-seven papers have been accepted by the Technical Papers Committee for delivery at the AWS National Fall Meeting to be held in Cleveland, October 8th to 12th. The papers, covering practically all phases of welding activity, will be presented in 19 technical sessions. In addition, two special sessions are being planned—a symposium on metallizing to be developed by the AWS Committee on Metallizing and a session on shop management.

A number of the accepted papers will be reports on latest methods and techniques for welding some of the relatively new commercial metals and alloys, such as titanium, zirconium, arc-cast molybdenum and magnesium-thorium alloys.

Two sessions on weldability and research are planned. The principal subjects to be covered will be notch toughness, brittle fracture, and weld metal porosity in mild steel. Two sessions on inert-arc welding also have been arranged. One of the papers will be a practical discussion on how to select the proper inert-gas-shielded arc-welding process.

Other highlights of the technical program include:

- Papers on weld inspection with radioactive isotopes and magnetic particles.
- A session on brazing and surfacing.
- A paper on a new nodular cast-iron welding rod.
- Sessions on piping, tubing and pressure vessels.
- Sessions on welding stainless steels, and welding aluminum.
- Papers on behavior of welded structures.
- A session on resistance welding including a paper on recent developments in magnetic force welding.
- Papers on the motor-arc welding process and stud welding.

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* Mr. Hoglund has been elected to higher office. Replacement in vacated office will be shortly effected.

AWS Adds Supporting Company Members

Several additional organizations have recently enrolled as Supporting Company members. They are as follows:

Airline Welding and Engineering, 785 N. Prairie Ave., Hawthorne, Calif.

Fairchild Engine Division, Fairchild Engine & Airplane Corp., Deer Park, N. Y.

LeTourneau-Westinghouse Co., 2301 N. Adams, Peoria, Ill.

St. Louis Car Co., 8000 North Broadway, St. Louis 15, Mo.

Trackson Co., 3333 S. Chase Ave., Milwaukee 1, Wis.

All of these enrollments became effective May 1st, except for the enrollment of the Trackson Co., which became effective on Apr. 1, 1956.

Ohio Nut and Bolt Co. Sponsors Sustaining Membership

The latest organization to become a Sustaining Member of the AMERICAN WELDING SOCIETY is the Ohio Nut and Bolt Co., 33 First Ave., Berea, Ohio. Research to develop new and better quality products for joining metal assemblies through resistance welding fasteners has been the constant aim of the Ohio Nut and Bolt Co. This 50-year old concern has pioneered in the development of resistance welding fasteners and now devotes its entire production to a line of over 400 stock fasteners and thousands of custom parts. Ohio Weld Fasteners offer the manufacturer assembling metal products the advantage of a fastener of single-piece construction which will provide indestructible welds, flush surfaces for mating parts, no protrusions to mar appearance of outside surfaces, added strength to product components in the

AIRCO
WELDING and BRAZING Hints

PROBLEM:

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SOLUTION:

Airco #22 Manganese Bronze Rod. A general purpose rod that should be in every welding shop where high strength brazed joints are required. Flows smoothly and produces sound joints on maintenance work when used with either Airco Marvel Flux or Airco High Test Liquid Flux. Airco #22 is also available with flux already coated on the rod to insure positive base metal protection.

Airco #20 Bronze Rod. Ideal for braze welding of steel, cast iron, malleable iron, copper, and dissimilar combinations of these metals. Airco #20 is available as a pre-coated rod using Hi-Test Flux. When this rod is purchased bare, either Hi-Test or Marvel Flux can be used for high strength welded joints.

Airco #27 Low Fuming Bronze Rod. For the brazing or braze welding of steel, cast iron, or bronze. Low fuming characteristics of this rod increase its applications in restricted areas. Recommended fluxes for use with Airco #27 are Airco Hi-Test or Marvel Flux. Flux coated rods also available.

Brazing and Braze Welding Flux. A good brazing flux cleans the joint, removes oxides created by heating, and picks up impurities in filler metal. Airco Hi-Test Flux, when properly applied, will accomplish these jobs.

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area of the weld, and vibration-proof attachment because Ohio Fasteners become an actual part of the metals to which they are attached.

Gregory F. Grey, chief engineer of the company, is the Sustaining Member Representative.

District 8 Officers Conference Scheduled for July 20

The District 8 Officers' Conference, scheduled in Minneapolis for Friday, July 20th, will be held during the famous Minneapolis Aquatennial Week. Russell H. Schleuder, of Electric Machinery and Manufacturing Co., is general arrangements chairman and W. E. Coleman, Linde Air Products, is committee vice-chairman. Other committee members are Ed Hall, Flour City Welding Co., Entertainment and Food Arrangements, Dave Dallman, Air Reduction, Welcome and Hospitality, and Roger Griffis, H. R. Toll Co., Transportation.

Russell H. Schleuder

W. E. Coleman

Hotel reservations will be made by participating officers at the Calhoun Beach Hotel and the conference will be held in the Skyline Room.

C. M. Clogston, Northwest Chairman, is arrangements chairman for a group of activities for women attending the conference, and the tour program includes a luncheon and trip through the famous Betty Crocker Kitchens on Friday morning.

Problems in sections will be presented by H. Jackson, District Director. After a noon luncheon, the conference will continue until the cocktail hour, when the women will join the men before dinner.

After dinner, participants will be entertained at the famous Aqua Follies at Theodore Wirth Pool, one of Minneapolis' famous lakes.

EMPLOYMENT SERVICE BULLETIN

Positions Vacant

• Teaching position. Assistant in welding engineering. Half time employment. Require B.S. degree in welding engineering, electrical engineering, metallurgical engineering, general engineering, civil engineering, or physics, with strong interest in teaching and research. Knowledge of the welding field is desirable but not essential. It is assumed that the candidate would be interested in pursuing an advanced degree in welding engineering. Acceptance by the Ohio State University Graduate School is also a condition of employment. Approximately 20 hours a week will be spent in teaching and research activities. Salary $1800 for nine months. (Out-of-state fees will be remitted.) Interested persons should forward completed résumé of educational and industrial experiences to: Department of Welding Engineering, Room 128, Industrial Engineering Building, Ohio State University, Columbus 10, Ohio.

• Instructor to teach courses in arc and gas welding. Good starting salary and pleasant working conditions. Bachelor of science degree preferred but not essential. This position is for a man with practical experience and a genuine interest in the field of welding. For further information, write to Dean of Engineering, California State Polytechnic College, San Luis Obispo, Calif.

• Welding Engineer. Age 26 to 40. Mechanical, electrical or metallurgical graduate. Experience in inert-gas tungsten-arc welding of heavy aluminum plate. Job involves customer consultation and extensive investigation of aluminum welding in product, research and development group. Salaried Personnel Department, Reynolds Metals Co., 2000 S. 9th St., Louisville, Ky.

Section News and Events

as reported to Catherine O'Leary

HARD-SURFACING MATERIALS

Albuquerque, N. Mex.—Manufacture and Uses of Hard-Surfacing Materials was the subject of a discussion and slides shown by Kenneth Carter of Stoody Co., Whittier, Calif., at the April 20th meeting of the *Albuquerque* Section held at the University of New Mexico Industrial Arts Building. The slides showed the manufacture of abrasion resisting alloys applicable to either arc or gas welding. Mr. Carter's discussion accompanying the slides was of considerable interest. After showing the slides, the speaker answered questions from the group in a manner which gave evidence of considerable knowledge about the manufacture, metallurgical characteristics and practical application of these products.

EUROPEAN WELDING TECHNIQUES

Birmingham, Ala.—"European Welding Techniques and Applications" was the subject of the April 10th meeting of the *Birmingham* Section, held at Hooper's Cafe.

Speaker for the evening was S. A. Greenberg, Technical Secretary of AWS, who reported on his tour of welding operations in eleven European countries last Spring. His talk covered welding processes and practices used in shipbuilding; structures, boilers and pressure vessels, piping, railroad equipment, automobiles and castings. Colored slides of scenes in European welding shops were used to illustrate the talk.

Following a question-and-answer period during which American and European practices were compared, Mr. Greenberg showed a series of scenic slides of European points of interest.

LECTURES ON WELDING METALLURGY

Cambridge, Mass.—A very successful series of lectures on the subject "Welding Metallurgy of High Alloy and Stainless Steels," sponsored by the *Boston* Section, started on Feb. 21, 1956 and ended on Mar. 27, 1956. The lecturer was Dr. Harry Udin, owner and director of Suburban Metallurgical Laboratory, formerly assistant professor of Metallurgy at Massachusetts Institute of Technology, where the lectures took place. This was a continuation of a series of lectures held last year. The course had an attendance of 253 who paid $3.00 per person for the entire course.

The subjects of the six lectures were as follows: Chemical and Physical Metallurgy; Review of Mechanical Metallurgy; Types of High-Alloy Steel and Welding Metallurgy of Ferritic Stainless Steel; Martensitic Alloys; Austenitic Stainless Steels—The "18-8's"; Miscellaneous High-Alloy Steels.

The lectures were very well received by executives, engineers, operators and salesmen. They were technical enough to give the engineer a review with new information as well as to be understood by the welding operator who gained a knowledge of some of the engineering problems encountered in welding techniques. A request by the body was made for a new series of lectures next year on "Nonferrous Alloys." These future lectures are now being planned.

PLANT TOUR

Bridgeport, Conn.—Fifty members of the *Bridgeport* Section took part in a guided tour of the Bridgeport Brass Co. plant on April 19th.

WELDING STAINLESS STEELS

Hammond, Ind.—Approximately 130 people attended the March meet

BOSTON SECTION SPONSORS LECTURES ON WELDING METALLURGY

More than 250 enrolled for the special lecture course covering the metallurgical aspects of welding stainless steel recently sponsored by the Boston Section. These lectures were conducted by Dr. Harry Udin

Among those who attended the course was Mrs. Frances Bourgue, the first female member of the Section

SPEAKERS AT MARCH MEETING OF CHICAGO SECTION

The dinner speaker at the Chicago Section was Capt. F. J. Kane who spoke on Nike installations

The technical speaker of the evening was Harry F. Reid. He is shown above, at left; Jay Bland is at right

ing of the *Chicago* Section held at Vogel's Restaurant in Hammond, Ind.

The dinner speaker was Capt. Francis J. Kane of the U. S. Army who gave an interesting talk on the operation of the Nike installations around the Chicago area. He showed a diagram on how the Nike missile operates and how the general protective system is set up to protect the Chicago area.

In addition, a 25-min movie prepared by the U. S. Army was shown which portrayed the training which is given to the personnel who operate these installations.

The technical speaker of the evening was Harry F. Reid, Jr., AWS, of the McKay Co., Chicago. His talk, which was a very interesting one, dealt with the welding of various types of stainless steels and the selection of proper types of electrodes for use with them. After his lecture, a question-and-answer forum was held, and from the numerous questions asked, it was apparent that the lecture had aroused considerable interest.

STRUCTURAL WELDING

Cleveland, Ohio.—A joint meeting of the *Cleveland* Section with the Construction Division of the Cleveland Engineering Society was held on Wednesday, April 11th, at the Manger Hotel.

At the opening of the meeting a 20-min, 16-mm, color film on "Oxyacetylene Flame, Master of Metals," was shown. This film gave some very good information on the subject.

"Welding of Multistoried Buildings Is No Myth" was the subject of a talk given by LaMotte Grover AWS, of the Air Reduction Sales Co., New York. In his talk Mr. Grover covered the design and control over welding for multistoried buildings and other structures to save cost and gain the fullest advantage from welding. Mr. Grover stated that, with the use of arc welding, 5 to 10% of the metals and materials used can be saved. Also prefabricating steel can save 20 to 40% in cost of erection. The speaker recommended that all construction companies and designers use the AWS Codes.

MECHANIZED ELECTRIC WELDING

Denver, Colo.—The April dinner meeting of the *Colorado* Section was held in the Festival Room of the Oxford Hotel on April 10th.

Coffee speaker was Bernard Beckwith, *Denver Post* police reporter. Mr. Beckwith told of some of his experiences as a reporter which were very interesting to the group.

The main speaker was F. R. Woodward AWS, of the Taylor-Winfield Corp., Warren, Ohio. His talk was on "Mechanized Electric Welding" which was accompanied by slides and moving pictures. It was quite interesting to see the machines working as robots during the welding of parts on a production line.

HARD SURFACING

Dayton, Ohio.—Forty members and guests of the *Dayton* Section were present at the regular monthly dinner meeting held on March 10th at the Dayton Engineer's Club.

The meeting opened with a sound film by the Ford Motor Co., showing automation and operations in the Cleveland Engine Plant and Foundry.

Featured speaker was Howard S. Avery AWS, research metallurgist for the American Brake Shoe Co., Mahwah, N. J. By the use of slides and excellent choice of general analysis, Mr. Avery presented some highly technical and valuable information in semitechnical language, on hard surfacing to minimize industrial wear. This technique combines the advantages of: adding wear resistance exactly where needed; easy use of very hard compounds and wear resistant alloys; ready application in the field; economical use of expensive alloy elements; protection in depth, and, a hard surface layer reinforced by a tough base.

Mr. Avery also pointed out that hundreds of hard-surfacing alloys are possible but most needs are served by a group of about 8 types: tungsten carbide composites; high chromium irons; martensitic irons; cobalt base alloys; nickel base alloys; martensitic steels; pearlitic steels; austenitic steels.

ANNUAL PLANT TOUR

Wallingford, Conn.—On Tuesday, April 17th, about seventy members and guests of the *Hartford* Section journeyed to Wallingford where the Wallingford Steel Co. played host to the Section's "Annual Plant Tour."

Guides were assigned to small groups, which were shown through this modern strip rolling mill. Founded in 1912 with an annual production of 6000 tons, it has grown to produce more than 60,000 tons.

The company was organized by E. B. Clabourne, now president, and G. B. Boyd. In 1935 controlling

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• SAVINGS in fabrication costs up to 50% have been reported by users of the Arcair Torch for weld preparation. The usual Arcair procedure is to butt unbeveled plates together and either tack weld or run a sealing bead along one side of the seam. The joint is then gouged from the opposite side, usually with one pass of the Arcair torch, leaving a clean even groove ready for welding. On heavy plates the backside is then gouged to sound metal and welded.

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EASE OF FITTING—as well as elimination of burning slab operations with necessary extra handling—plus the fact that both plates are prepared by a single pass of the Arcair Torch which is economical to operate, make this method faster and cheaper than those previously used.

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interest was acquired by the Ludlum Steel Co., and in 1938 when Ludlum Steel and Allegheny Steel merged, Wallingford Steel became part of that corporation. In 1949 operations were expanded to produce stainless steel piping and tubing.

Following the tour, the group moved on to the Yankee Silversmith, one of New England's outstanding eating establishments. After cocktails, a delicious fried chicken dinner was served which was thoroughly enjoyed by all.

Chairman Al Risch introduced the speaker of the evening, W. H. Grinold, who gave a brief outline of the history of Wallingford Steel and its future. One of the high points of his talk was the part that automation will have in the future of the company.

Due to the widespread interest evoked by this tour, the Boston, Bridgeport, Worcester, Western Massachusetts and Northern New York Sections were also invited to attend.

INERT-ARC WELDING SPEAKS IN HOUSTON

Houston, Tex.—The *Houston* Section held a meeting on March 28th in the Ben Milam Hotel with 80 members present.

A paper entitled "Modern Methods of Inert-Gas Welding as Used in Industry Today" was presented to the group by Harry A. Huff, Jr., [MW], process representative for Air Reduction Magnolia Co.

Several points of interest were brought out in the talk including the fact that inert-gas welding of pipe joints in the field improved the process of joining pipe especially for welding the roof pass. Lower cost, faster welding speeds and deeper

Technical speaker at March 28th meeting of Houston Section was H. A. Huff. His topic dealt with inert-arc welding

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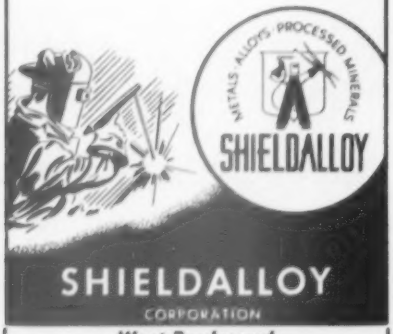

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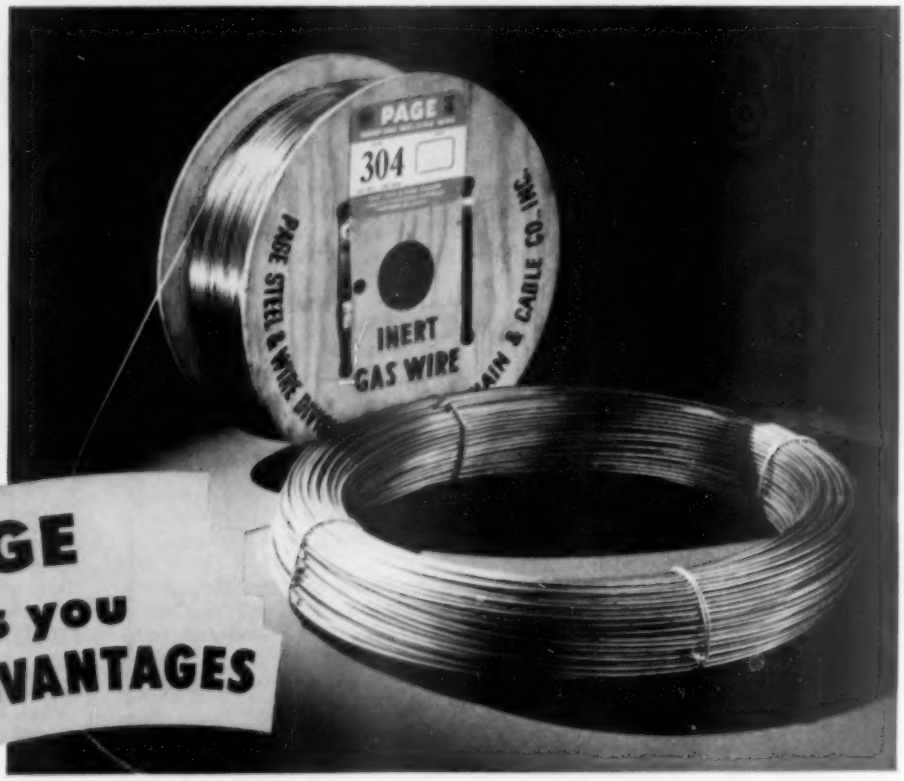

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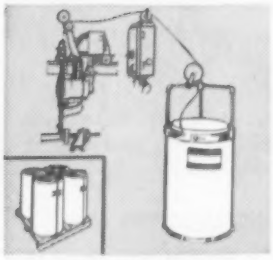

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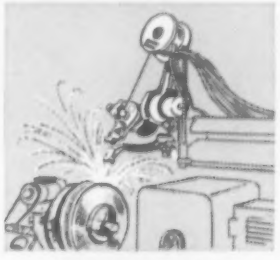

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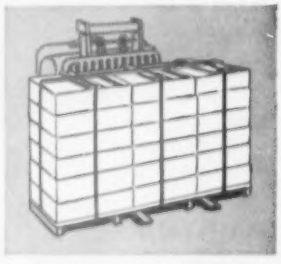

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AT THE MARCH MEETING OF THE LOS ANGELES SECTION

Guest speaker at the March meeting of the Los Angeles Section was J. R. Gage, director of Military Relations for Douglas Aircraft, Long Beach

Francis V. McGinley, chairman Los Angeles Section, with a group of new members of the opposite sex, all skilled welders and employed at the Douglas Aircraft Long Beach Plant

penetration have been realized by using helium gas with d-c and the thoriated tungsten electrodes.

MAINTENANCE WELDING

Cumberland, Ind.—The March meeting of the *Indiana* Section was held at Buckley's Restaurant in Cumberland, where an excellent dinner was served to 35 members and guests.

Following dinner, a color sound film was shown entitled, "This Is Magnesium—Treasure from the Sea" which illustrated the extraction of magnesium salts from sea water and reduction to the metallic state.

Speaker for the evening was J. A. Blastic, Welding Engineer of Oldsmobile Division, General Motors Corp., Lansing, Mich.

The subject was "Maintenance Welding" and was illustrated by slides.

The repair of fractured cast-iron structural machine members by means of braze welding was discussed and materials, preparation, and procedures outlined on several specific applications.

The repair assembly of drills and other tools using brazing and braze welding was described, and various heating methods were covered.

FLASH WELDING

Hollis, L. I.—At the March 8th dinner meeting of the *Long Island* Section, R. D. Libert, of the A. O. Smith Corp., Milwaukee, Wis., addressed 60 members of the Section on the subject of "Flash Welding." Mr. Libert showed some excellent slides demonstrating the equipment now being used in production at their plant. Of special interest was his discussion concerning the flash welding of low-alloy high-strength steels of the AMS6428 and 6434 alloys. The entire audience was interested in the latest developments by the A. O. Smith Corp. of their research in the flash welding of titanium. Following Mr. Libert's talk, there was a very interesting question-and-answer period which answered many questions on flash welding that were not covered in Mr. Libert's talk.

BUSINESS SESSION

Los Angeles, Calif.—An Executive Committee dinner meeting of the *Los Angeles* Section was held on April 16th, in the Trojan Room of the

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Available in 200, 300, or 400 ampere models with ratings at 60% duty cycle. Power Factor Correction can be supplied.

SRTA ac-dc WELDERS . . .

. . . for BOTH inert gas and metallic arc welding. Instant change from ac to either straight or reverse polarity dc. Power Factor Correction on all models. UNITRAN control circuit removes need for mechanical control and delivers outstanding uniformity throughout welding range. Built in high frequency, combined with balancing resistor, which is in series with transformer secondary, make this the welder for inert gas and metallic welding.

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Articles of business included expense allowance for Section representation at Spring Meeting in Buffalo, N. Y., Annual Reunion Night, program advertising, membership, which has been a large scale program in this Section during the fiscal year, and the approval of an annual scholarship award.

AIRCRAFT PLANT TOUR

Long Beach, Calif.—The March meeting of the *Los Angeles* Section featured one of the most successful and well-organized plant tours ever attended by the members. The tour, which was made possible through the untiring efforts of C. B. Smith, program chairman of the Los Angeles Section, R. C. Hayes, chairman of Ways and Means Committee, Los Angeles Section and L. M. West, secretary of the Aircraft and Rocketry Panel, Los Angeles Section, was enjoyed by 170 members, which included the Long Beach section, and members from the San Diego Area.

The tour consumed 2½ hr of time and was conducted by members of the Douglas Long Beach Management Club who were later dinner guests of the Section. The participating group included the first lady welders to become members of the AWS on the Pacific Coast. All these girls are employees of the Douglas Long Beach Plant, carrying as many as 11 Military Certifications and well versed in the trade.

Following the tour, cocktails and dinner were served at the Lakewood Country Club with 250 in attendance.

The guest speaker of the evening was J. R. Gage, director of military relations for the Douglas Co., who spoke of the outstanding growth, accomplishments and progress made since its inception in both the military and commercial field of aircraft production.

Mr. Gage's talk was well presented and greatly enjoyed by all those present. Upon conclusion, he was presented with a pen set by F. V. McGinley, chairman of the Los Angeles Section, as a token of appreciation. This was followed by a motion picture in color titled "Douglas Achievements" concluding the program for the evening.

INERT-GAS WELDING

Huntington Park, Calif.—A regular monthly dinner meeting of the *Aircraft and Rocketry Panel, Los Angeles* Section was held on Apr. 5, 1956, at the Elks Lodge, Huntington Park, Calif., with 120 members and guests in attendance.

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Is there any other welder that compares with the *exclusive* advantages offered by the Westinghouse RA d-c welder? Such outstanding advantages as . . .

An exclusive 100% duty-cycle arc drive to prevent sticking and pop-outs at all settings that gives a hot start for easy starting.

Longer welder life—used indoors or out—because the windings are double-dipped and baked in silicon-fortified Bondite . . . because the exclusive baked-on enamel finish on Bonderized steel assures weatherproofing.

"Wide-amp control" far exceeds NEMA Standards in both the high and low ranges—another exclusive. Arc stability and balanced load with Westinghouse three-phase selenium rectifiers—originated by Westinghouse.

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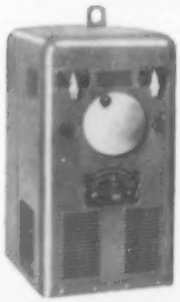

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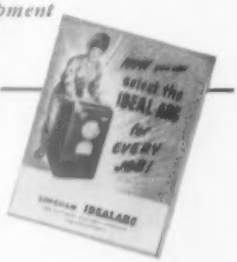

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DINNER MEETING HELD BY EXECUTIVE COMMITTEE OF LOS ANGELES SECTION

Seated around the table at the April 16th dinner meeting are (*left to right*): D. P. O'Connor, A. Flanigan, S. R. Lanier, W. Tenner, R. C. Hayes, F. V. McGinley, C. B. Smith, H. Meredith, F. R. Drahos, L. M. West, M. Ochieano

The guest speaker for the evening was Keith Lampson, group leader of metallurgy for the Marquardt Aircraft Co. The subject was "The Tungsten Inert-Gas Welding of Magnesium-Thorium Alloys."

Mr. Lampson gave a thorough coverage of the development work conducted at Marquardt on the welding and forming aspects of this metal.

The work at Marquardt was prompted by the desire to utilize the excellent strength to weight ratio exhibited by magnesium-thorium alloys. Attractive properties are retained up to 700° F. The investigation conducted indicated that this new class of magnesium alloy was readily weldable when special precautions were observed. Preheat and all technique requirements were thoroughly evaluated and optimum conditions established. Mr. Lampson's paper was well supported with glass slides. Upon conclusion, he was presented with a pen set in appreciation of the fine contribution made.

Immediately following the dinner and prior to introducing the guest speaker, Chairman Harlan Meredith gave a brief résumé of the status of the membership drive then in progress.

A unique method of obtaining members who otherwise could not afford to join the SOCIETY was illustrated by Mr. Meredith and his associates at Airline Welding. This company has adopted the payroll deduction method for all employees desiring to become member of AWS resulting in that organization joining 100% strong.

WELDING IN AIRCRAFT INDUSTRY

Baltimore, Md.—The April meeting of the *Maryland* Section was held Friday, April 20th at the Engineers Club in Baltimore.

The technical speaker for the evening was Lewis R. Kovac AWS, supervisor, Nuclear Manufacturing Research for the Glenn L. Martin Co. Mr. Kovac's talk was rather general covering the problems encountered in getting the proper material for nuclear use and the joining of these high alloys. A film was shown in connection with the talk.

The after-dinner talk was presented by Chancey Tatum of the C. & P. Telephone Co. He used as his subject "You Are What Your Voice Is," which was quite interesting and informative.

PAST CHAIRMAN'S NIGHT

Milwaukee, Wis.—The *Milwaukee* Section honored its past chairmen at the March 23rd, "eat all you want" Smörgåsbord dinner meeting. Twelve of these honored guests were present. They were seated at the head table and were introduced to the members present.

The largest crowd of the year turned out, despite very bad weather, to honor the past chairmen and to hear a very informative and popular educational talk by Roger W. Tuthill AWS of the General Electric Co. Mr. Tuthill described the equipment available for CO_2 and inert-gas metal-arc welding, the fundamentals of the process in layman's terms and several specific applications of the CO_2 welding process. The speaker emphatically stated that the CO_2 welding process is so new that very few positive statements can be made concerning the process because "tomorrow someone may prove just the opposite."

In other words, Mr. Tuthill's con-

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versational talk was meaty and down-to-earth. Nearly everyone present felt that his time had been well spent, and carried away something that he may be putting into practice within a very short time.

SUBMERGED-ARC WELDING

Milwaukee, Wis.—Due to illness, Norman G. Schreiner, of the Linde Air Products Co., New York, was unable to address the April 20th meeting of the *Milwaukee* Section on "What Can Be Done with the Welding Arc."

The Linde Air Products Co. rushed a substitute, William B. Sharav, division head, Newark, N. J., who presented an excellent impromptu talk on "Submerged Metal-Arc Welding." Fortunately, Mr. Sharav was on a field call in Indianapolis and had no trouble in extending his trip to Milwaukee. The company rushed a bundle of slides to Milwaukee and they arrived "in the nick of time."

Only a man with a thorough understanding of his subject could have done such a fine job. In the first portion of his lecture, Mr. Sharav described in very simple language, the submerged-arc process. The functions of the wire, the flux, the drive mechanism, the control circuit and the power source were fully enlarged upon. Most welding is done with a single wire, but many companies are discovering that, with adequate tooling and groove preparation, as many as four wires and complex circuits can be used to obtain tremendous welding speeds and economy.

In the second portion, Mr. Sharav presented a number of slides showing applications of submerged-arc welding and the appearance of good and bad welds and what caused their appearance.

ALL-POSITION WELDING

Omaha, Neb.—The *Nebraska* Section held its monthly meeting on March 23rd at the Birchwood Club in Omaha. The meeting was preceded by a social hour and dinner.

Guest speaker was R. K. Lee, technical director in charge of research for the Alloy Rods Co. His topic was "All-Position Welding with Iron-Powder Low-Hydrogen Electrodes." The members and guests found this presentation to be very interesting and informative.

FORUM MEETING

Newark, N. J.—Seventy-three members and six guests attended the *New Jersey* Section's "Forum Meet-

"When welding cast iron, I call for the Airco 77 Electrode"

The deposit of the Airco 77 Electrode is of higher tensile strength than cast iron. It is excellent when machinability of the deposit is not required. The weld metal bonds well, and since it can be applied with comparatively low currents, the hard areas at the fusion zone are materially reduced in cross section. Some applications for the Airco 77 electrode are welding of cylinder blocks and heads, machine parts and large frames.

This is but one of many electrodes in Airco's complete line that also includes stainless steel, hard-facing, cast iron, general and special purpose electrodes. Send for free Airco Electrode Guide which will help you select the right electrode for your specific job. Request catalog 1318-WJ.

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A Report on Automatic Arc Welding

A G-E WELDING ENGINEER EXPLAINS ARE TURNING MORE AND MORE TO

Roger W. Tuthill, Welding Process Engineer for the General Electric Company's Welding Department, answers some of the more frequently asked questions about the gas-shielded, consumable-electrode welding process.

Mr. Tuthill's answers explain the increased attention this process is receiving from production and welding people as automation begins to make greater demands on production welding.

Mr. Tuthill has been active in research and development on Fillerarc welding, General Electric's gas-shielded process, and has had a number of papers published on the subject.

Q. What is the gas-shielded welding process?

A. Gas-shielded welding is a consumable-electrode arc welding process which uses a reel of bare electrode wire fed mechanically through a welding head. Gas, such as carbon dioxide or argon, flows around the electrode to form a protective shield about the arc.

Q. Is there anything particularly new about gas-shielded arc welding?

A. Yes—if you're talking about *automatic* gas-shielded arc welding!

Historically, powdered flux has been used as the shielding agent in automatic arc welding, mainly because no gas process was economically feasible for welding mild steel. However, gas-shielding was attractive to many prospective users because it eliminated the many problems created by the use of flux—expensive flux recovery systems, flux inclusions in welds, flux in the air, more precise fixture requirements, and other difficulties.

Gas-shielding has been used for welding non-ferrous and stainless steels, but the relatively high costs of the inert gases used made gas-shielding impractical for mild steels.

Recently, the successful application of low-cost carbon dioxide as a shielding gas has finally made it economical to use gas-shielded equipment for welding mild steels. For example gas savings of 90% over inert gas costs have been reported. Since by far the most welding being done today is on mild steel, it is easy to see why this development is causing so many production people to turn to automatic gas-shielded arc-welding for answers to their production welding problems.

Q. Does a gas-shielded automatic welding system cost any more than other automatic arc welding systems?

A. The cost of setting up a gas-shielded system is about the same as for a comparable submerged-arc automatic system.

For example, while the *purchase* price of gas-shielded automatic equipment may be more than that of a submerged-arc system, the fact that there is no need for installing expensive flux recovery equipment and other cleaning systems with gas-shielded welding easily makes up the purchase price difference.

Q. Does the quality of welding done with gas-shielding compare with other welding processes?

A. Quality of welds made with the gas-shielded automatic welding process compares very favorably with other processes. Since no flux is used there is no possibility of flux inclusions; penetration is usually deeper; and the visible arc permits full control during welding. This visible arc permits less expensive fixtures to be used, an important cost factor in automatic welding.

Q. How about the speed and flexibility of a gas-shielded system? Can it be easily integrated into a production line?

A. A gas-shielded system can be used in production line welding as easily as any automatic welding system.

For example, the G-E Fillerarc system has electrode wire feed speeds which range up to 1000 inches per minute.

WHY FABRICATORS OF MILD STEEL AUTOMATIC GAS-SHIELDED WELDING

The automatic head can be rotated through 360 degrees and can be used for circular or seam welds, and, if necessary, more than one welding head can be used to make multiple welds.

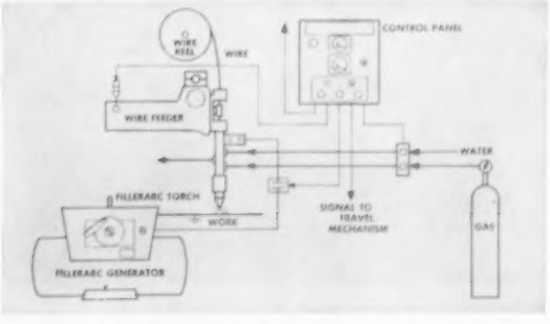
These characteristics make the Fillerarc system flexible and fast enough for almost any production line. Perhaps of equal importance to production people is the system's insensitivity to incoming line voltage, which assures constant production speed and weld quality.

Q. To sum up, what are the really important advantages of the automatic gas-shielded welding process?

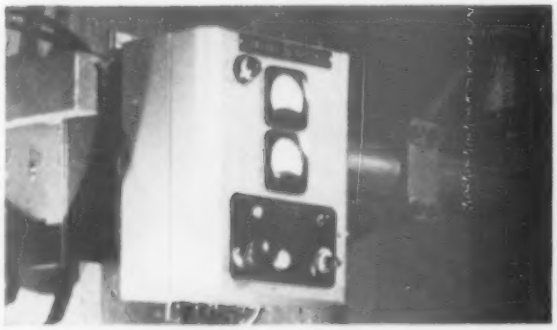
A. In a few words, the most important advantages of the automatic gas-shielded process are flexibility, high welding speeds, uniform weld quality, elimination of the cleaning problems associated with the use of flux, versatility for use with all types of metals, and most important of all, the ability to use low-cost carbon dioxide for shielding.

For more information about Fillerarc automatic gas-shielded welding see your nearby G-E Welding Distributor, or write for Bulletin GEC-1334, Section 713-4, General Electric Company, Schenectady, N. Y.

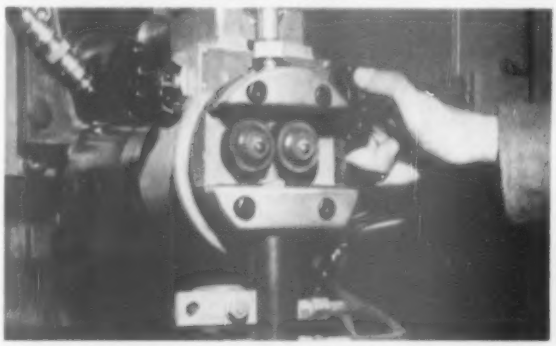
Now, General Electric offers four power sources for automatic gas-shielded welding—three new 800-amp rectifier welders and the already-proved 450-amp Fillerarc motor-generator set. They offer a complete choice of output characteristics and automatic features to suit your welding needs.



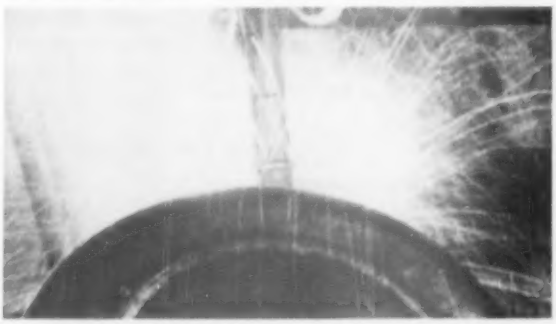
G-E FILLERARC EQUIPMENT is the only complete equipment especially designed for consumable-electrode, gas-shielded welding. Simplicity of the system makes possible use of less expensive fixtures and greater over-all efficiency.



WIDE RANGE OF WIRE-FEED SPEEDS—up to 1000 inches per minute—makes the G-E Fillerarc system flexible enough for any production line. Speed is constant since system is insensitive to normal line-voltage changes.



FLEXIBILITY OF FILLERARC SYSTEM is also demonstrated by the automatic head. It rotates 360 degrees, allowing even overhead welding. Arc is completely visible since gas is used as the shield instead of flux.



CIRCULAR OR SEAM WELDS may be made on stainless steel, copper, aluminum, and other metals—using inert gas. Fillerarc power sources, rectifier or motor-generator, and carbon dioxide combine for low-cost, quality welds on mild steel.

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ANNOUNCING . . .

3 NEW G-E Power Sources for Automatic Welding

Now, three new General Electric 800-amp rectifier welders join the already-proved Fillerarc 450-amp motor-generator set as power sources for the expanding gas-shielded automatic welding process.

The three new power sources are designated FILLERARC, REGULARC, and DIRECTARC and offer a complete choice of output characteristics and automatic features. (See comparison chart below.)

FILLERARC—gives you the ideal power source for automatic gas-shielded welding. Like the 450-amp Fillerarc motor-generator, this rectifier welder has a unique rising volt-ampere characteristic which automatically matches the arc requirements for all electrode wire feed speeds. It is immune to changes in incoming line voltage, thus assuring consistent weld quality.

REGULARC—The first *true* constant-potential power source offered for automatic welding, this welder provides all the features of the Fillerarc model except that it has a flat volt-ampere characteristic. This is the set for you if your application requires regulation of incoming line voltage and only relatively small changes in electrode wire feed speeds.

DIRECTARC—With minimum investment, Directarc offers the same high quality design and construction of the other models without the automatic features. Directarc is the choice for you if you have a well-regulated incoming line voltage and your application requires only one arc length and electrode wire-feed speed.

QUALITY RECTIFIER FEATURES—All three models offer the same high quality you've come to expect in G-E rectifier welders—quiet operation, combination cleaning-cooling fan, easily removable side covers, and Class H silicone insulation.

For more information see your nearby G-E Welding Distributor (He's listed in the yellow pages of your phone book) or write Section 713-5, General Electric Company, Schenectady 5, N. Y.

Power Source	Output Volt-ampere curve	Immune to Incoming Line Voltage Change	Adjustable Starting Voltage	No Change in Arc Length with Change in Electrode Wire Feed Speed
FILLERARC	Rising	Yes	Yes	Yes
REGULARC	Flat	Yes	Yes	No
DIRECTARC	Essentially Flat	No	No	No

Progress Is Our Most Important Product

GENERAL ELECTRIC

ing" held on April 17th at the Essex House Hotel in Newark.

The panel of experts were: W. Apblett, Foster Wheeler Corp.; Wm. Benz, M. W. Kellogg Co.; S. Sullivan, Air Reduction Sales Co.; H. Hoffman, Todd Shipyards Corp.; A. Steinberger, Curtiss-Wright Corp.; and F. J. Pilia, Linde Air Products Co., moderator.

The questions and problems presented to the panel covered inert-gas metal-arc and tungsten-arc welding, CO_2 welding, low-hydrogen electrodes, a-c and d-c welding and operating factors.

Chairman Thomas McElrath of the Membership Committee reported an increase of over one hundred members bringing the Section's membership up to 400.

INERT GAS WELDING

New York, N. Y.—The April 10th meeting of the *New York* Section consisted of a panel discussion on Inert-Gas Welding, with Dan Bellware of the International Nickel Co. as moderator. The panel members and their subjects were as follows:

Ken Spicer, International Nickel Co. Subject: Welding of Nickel Alloys.

Bill Davis, Air Reduction Sales Co. Subject: Welding of Aluminum and Aluminum Alloys.

Roger Tuthill, General Electric Co. Subject: CO_2 Welding of Steels.

Joe Imperati, American Brass Co. Subject: Welding of Copper and Copper Alloys.

Jack Taylorson, Linde Air Products. Subject: Welding of Stainless Steels and Welding of Heat-Treatable Alloys.

Cleanliness of the parts being welded, as well as adequate gas coverage, were stressed as being the main criteria of the processes by all panel members. Mr. Tuthill discussed the economy of using carbon dioxide as the shielding gas in welding carbon-steel joints, this process being used mainly on fillet and lap type welds.

A lively discussion followed the short presentations by the panel members and a very enlightening evening was enjoyed by all. The meeting was held at Schwartz's Restaurant, 54 Broad St., New York City.

NEW JERSEY SECTION HOLDS FORUM MEETING

Members of the panel of experts featured at April 17th meeting of New Jersey Section were (*left to right*): A. Steinberger, W. Benz, F. Pilia (moderator), H. Hoffman, S. Sullivan, W. Apblett

These are the members of the Membership Committee who reported excellent progress. Back row, standing (*left to right*): R. V. Thornton, G. Giangrandi, J. Fitzgerald, F. McGrath, J. Gunning. Front row, seated (*left to right*): F. Portik, G. Kotcher, T. McElrath, J. Shanley, J. Murphy

SPECIAL

SPECIAL

Due to the recent death of Mr. Fred C. Archer, it is necessary to liquidate the inventory of electrode ovens to settle his estate. We offer the Archer Blueweld electrode oven at the following prices:

Model 400 100 or 220 volt

$100.00 each

with dual chemoelectric dehydrators

$125.00 each

F.O.B.: Newark, N. J.

The manufacture of this unit will continue and replacement parts will be available.

Send orders to your local welding equipment dealer or to

ESSEX WELDING EQUIP. CO., INC.

17-19 Tichenor Lane

Newark, N. J.

New Jersey's largest distributor of welding equipment.

where dinner was served prior to the technical session.

ANNUAL LADIES NIGHT

Mansfield, Ohio.—Fifty-seven couples attended the Second Annual Ladies Night of the *North Central Ohio* Section held on April 21st. The dinner-dance was held at the Grotto Hall in Mansfield. All of the ladies were given colorful corsages.

The cocktail hour before dinner offered an opportunity for many of the wives to renew acquaintances. A splendid dinner was prepared and served by members of the Grotto. After dinner 15 valuable door prizes were awarded to the lucky ladies.

Dancing from 9:00 to 1:00 was to the accompaniment of Tony Callomello and his band from Mt. Vernon. All agreed that the evening was highly successful and everyone is looking forward to next year.

STAINLESS STEEL CLAD

Oak Ridge, Tenn.—Fifty members and guests of the *North East Tennessee* Section attended a dinner meeting on March 19th held in the Oak Terrace Star Light Room.

Messrs. Keary and Weaber of the Lukens Steel Co., Coatesville, Pa., presented an interesting discussion on stainless-steel cladding which included the production, application and fabrication of clad steel. A comparative cost with other corrosion-resistant materials was also covered.

THE BIG SPHERE

Minneapolis, Minn.—The *Northwest* Section members heard a beautifully delivered talk on Monday, April 9th, at the Covered Wagon, by Christian Arne AWS, research engineer for the Chicago Bridge and Iron Co. He told how the big spherical vessel, erected to test the *Nautilus* atomic engines, was fabricated. The huge vessel was dubbed the "Big Sphere" by all the people associated with it.

Mr. Arne designed and constructed the first multispheres. His talk on this sphere was illustrated by movies and slides depicting erection difficulties and how they were solved. Subassembly fabrications were automatically welded by the submerged-arc process and field erection was accomplished by manual-arc welding. Mr. Arne is the author of a new method of spherical geometry and has also contributed to the third edition of the AWS WELDING HANDBOOK.

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Offers You Over 200 PROVEN Standard Stock Models of Quality POSITIONERS "POSITIONEERED" to your exact Requirements
Patented
Aronson TracTred (T. M. Reg.) Turning Rolls for thin walled heavy cylindrical work to 27 tons capacity. Zero to 100 IPM turning speed and Built In Grounding.
Heavy Duty Precision Built Rubber and Steel Tired Turning Rolls, 100% overload protected. Capacities to 250 Tons. Also Tilting Rolls, Pipe Rolls and Rail Cars
Heavy Duty Gear Driven Positioners, with Magnetic Braking, Mercury Grounding, and Optional Speeds. Capacities to 24,000 lbs.
Fully Automatic Gear Driven Positioners, featuring Power Elevation, Tilting and Rotation. 5,000 lbs. Capacity.
Heavy Duty Floor Turntables with precision speed control and Magnetic Braking, used for welding, burning, X-raying, etc. Capacities to 75,000 lbs., various heights and speeds.
Model D Gear Driven Positioners. Compact. Precise. Rugged. Capacities to 1000 lbs.
Bench Turntable Automatic Positioners with Mercury Grounding Capacities to 500 lbs.
Patented
Aronson Universal Balance Positioners (T.M. Reg.) position your weldments effectively, instantly for downhand welding. Capacities to 2000 lbs.
Rugged Head and Tail Stock for positioning bulky weldments between centers. Table Backup for Zero Deflection. Magnetic Braking. Capacities to 160,000 lbs.
Aronson Twinner Permanent Magnetic Clamps, six models with thousands of uses in welding set-up work. Write for bulletin.
Quality PRODUCTS by Aronson MACHINE COMPANY
ARCADE, NEW YORK

POWER SHOVELS

Erie, Pa.—On April 24th, 86 members of the *Northwestern Pennsylvania* Section visited the plant of the Bucyrus-Erie Co., where they saw production manual-arc welding, submerged-arc welding, automatic flame cutting and flame-hardening processes. This is one of Erie's largest metal fabricators. Their new addition has resulted in the procurement of new equipment and the development of new methods.

CARBON DIOXIDE

Erie, Pa.—G. R. Rothchild AWS, section head, Metallurgical Process Division, Air Reduction Co., Murray Hill, N. J., was the speaker at the March 27th dinner meeting of the *Northwestern Pennsylvania* Section held at the Danish Club in Erie. His subject was "CO_2-Shielded Consumable-Electrode Arc Welding."

LADIES NIGHT

Peoria, Ill.—The April 18th meeting of the *Peoria* Section was held at the Mecca Supper Club in Peoria with fifty members and guests present.

This was Ladies Night, and W. Gauss, well-known Peorian, showed film taken by him while vacationing in Mexico. This was greatly enjoyed by all, as Mr. Gauss' interesting narration of the film made one feel as though he were actually on a Mexican vacation.

RESISTANCE WELDING

Philadelphia, Pa.—S. L. Messina, welding metallurgist for Grumman Aircraft Engineering Corp., presented a paper entitled "Resistance Welding

M & T CONTROLLED-ARC POWER SUPPLY

for semi- and full-automatic welding

Here's another new Metal & Thermit product — the M & T constant voltage rectifier-type DC Welder as developed originally by the Glenn Co. When used in conjunction with a constant speed wire feed for semi- and full-automatic welding, it . . .

SIMPLIFIES OPERATION — for all practical purposes it maintains a constant arc length during entire welding cycle, thereby assuring a uniform deposit.

IMPROVES WELDING — uniform deposits are of high quality, regardless of conditions which normally affect arc length such as poor fit-up, tack welds, etc. — avoids undercutting on horizontal welds.

SPEEDS PRODUCTION — instantaneous starting and recovery get job underway faster with higher average rate of deposit — practically eliminates rejects.

CUTS POWER AND INSTALLATION COSTS — high efficiency and power factor permit lower wiring and operating power costs.

M & T Controlled-Arc Power Supply units are saving time and cutting costs on many semi- and full-automatic welding operations. Write for details on how they can help you.

WELDING SUPPLIES
RADIOGRAPHIC EQUIPMENT
PLATING MATERIALS
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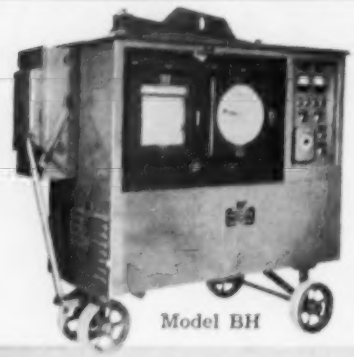
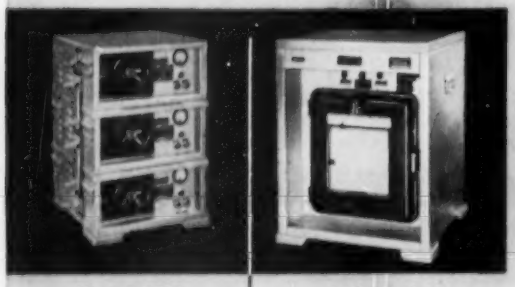
The Smith-Dolan System of
Low Frequency Induction Heating


Model BH

Preheats and Stress Relieves

Easy-to-Operate Equipment for Preheating and Stress Relieving High-Pressure Alloy Steel Weldments

This mobile-type low frequency induction heater, **Model BH**, is a self-contained unit that delivers up to 1800°F for preheating and stress relieving chrome molybdenum and stainless steel. Operators find this equipment easy to use in field or shop, as well as time saving. It's guaranteed to produce thorough penetration in heating large and heavy wall weldments!



Model U-P
This portable, low frequency induction heater offers three-high stack 30 kva - 10 kva per unit. Buy one or stack 2 or 3 units for increased capacity.

Automatic Control Cabinet
Used with Model U-P units (shown at left) and Model GC Duplex 120 or 150 kva induction heaters.

ELECTRIC-ARC INC.
161 Jelliff Avenue
Newark 8, New Jersey

Also available — a complete line of High Frequency Induction Heaters, AC and DC Arc Welders. Write for complete catalog.

Applications in Aircraft Manufacture" to a small but enthusiastic audience at the March 19th technical session of the *Philadelphia* Section. Mr. Messina and Al Lodestro, welding engineer at Grumman, combined their knowledge to answer the continuous flow of questions throughout the evening.

INERT-GAS ARC WELDING

Portland, Ore.—The *Portland* Section held its monthly dinner meeting at the Heathman Hotel on April 10th. E. C. Nollman [illegible], Pacific Northwest district engineer for Linde Air Products Co., gave an interesting and informative talk on inert-gas tungsten-arc welding. It included the mechanics of hand and machine cutting with this process, discussion of apparatus needed, and the use of shielding gases. Conditions for cutting aluminum, magnesium and copper were described and sample cuts in these materials were inspected by the group. Slides were shown illustrating all phases of the talk and the use of this process for the fabrication of aluminum railroad tank cars.

RESISTANCE WELDING AUTOMATION

Rochester, N. Y.—Over 50 members and guests attended a dinner meeting of the *Rochester* Section held on April 16th at the Liederkranz Club.

F. A. Bodenheim, Jr., [illegible], of the Federal Machine and Welder Co., Warren, Ohio, spoke on "Case Histories of Resistance Welding Automation," in which he outlined the evolution of high production special resistance welding equipment to replace a number of standard welding machines. Slides and movies provided graphic evidence of the cost reduction obtained.

CONTROLS FOR RESISTANCE WELDING

Saginaw, Mich.—The annual business meeting of the *Saginaw Valley* Section was held on April 12th at the High Life Inn. An excellent dinner was enjoyed by 107 members and guests. The elected officers for the coming year were announced as follows: Chairman, R. F. Woollard; vice-chairman, W. F. Williams; secretary, Paul Klain; treasurer, Paul Thorne; executive committee, J. R. Cammeron, Floyd Mack, J. Nichols and Bill Tingler.

Speaker at the technical session was Max E. Butler, welding engineer, Frigidaire Division, General Motors Corp. Mr. Butler's speech on "Electronic Controls for Automatic Resist-

In ore clean-up buckets

FABRICATION SIMPLIFIED WITH USS "T-1" STEEL

(and weight reduced more than ½ ton)

This photo courtesy of Blaw-Knox Company.

HALF AS THICK! In the trays for giant ore clean-up buckets, 1¼" USS "T-1" Steel Plate, with a yield strength of 90,000 psi., replaces cast trays which were as much as 2½" thick. The new buckets—lighter in weight by more than half a ton — and expected to outperform the heavy cast trays, will be used at United States Steel's South Works.

• The trays of ore clean-up buckets must have phenomenal shock and abrasion resistance to hold up under constant scraping and scouring along the steel bottoms of ore boats. They are commonly made of heavy steel castings. But recently, Blaw-Knox Company, Pittsburgh, Pa., *fabricated* trays for several new buckets from USS "T-1" Steel Plate. This amazing new alloy steel assures the needed strength and durability, plus important fabricating advantages.

LESS WEIGHT — LESS EXPENSE

Biggest single advantage of fabricating from "T-1" Steel Plate is less weight. New trays weigh only 4,021 pounds each, compared to 5,068 pounds for comparable cast manganese steel trays. Thus, "T-1" decreases the weight of the bucket and reduces shipping and handling costs.

What's more, fabrication from "T-1" simplified the building of these huge buckets. It eliminated the expensive patterns needed for cast trays. Because "T-1" has tremendous resistance to impact abuse and abrasion, it is expected that it will outperform previously used materials.

For these ore buckets, "T-1" Steel is flame-cut to size, *cold formed* in a 1,250-ton press, drilled and then riveted to the bucket shell. "T-1" also can be welded—without pre- or post-heating. Because of its unusual combination of properties, it is cutting costs in many rugged applications.

LOOK AROUND YOUR SHOP

In your own equipment, or in the products you make for others—wherever you would like to increase service life . . . wherever you would like to reduce fabricating costs of heavy-duty parts—look into the possibility of using "T-1" Steel. Competent technical advice is always available, of course — free of charge — from United States Steel. Write, wire, or phone for complete information. United States Steel, Room 5219, Pittsburgh 30, Pa.

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USS "T1" CONSTRUCTIONAL ALLOY STEEL

USS

UNITED STATES STEEL

ance Welding Equipment," was delivered in a very fluent and understandable manner. He highly recommended the use of a drawer type timer mounted as a multiple unit in a cabinet package and used for sequencing and resistance weld time. He told of having this set up in approximately two thirds of the Frigidaire Division, thereby leading to greater efficiency. Mr. Butler also showed pictures of different circuits and the machines on which they are used, and explained how they saved time on operation.

An interesting movie, "Magnifying Time," by Eastman Kodak, was run showing various pieces of equipment at slow motion which should help solve many industrial problems.

PLANT TOUR

Decatur, Ill.—Ninety members of the *Sungamon Valley* Section toured the plant of the Caterpillar Tractor Co. in Decatur on April 10th. Dinner was served in the cafeteria prior to the tour.

PLANT TOUR

San Jose, Calif.—Some 150 members and guests of the *Santa Clara Valley* Section took part in a tour of the Ordnance Division of the Food Machinery and Chemical Corp. This was a wonderful opportunity to see the various phases of manufacturing involved in the production of the M-59 Army Ordnance Personnel Carrier. Approximately 115 members and guests had dinner at Vahl's Restaurant in Alviso before the tour.

NONDESTRUCTIVE TESTING

Shreveport, La.—George L. C. Dehn, Manager of the Southwestern District, Magnaflux Corp. talked on "Nondestructive Testing" at the April 19th meeting of the *Shreveport* Section held at the Caddo Hotel. The speaker pointed out that the cost of nondestructive testing can vary over a wide range depending on methods used and thoroughness. Because of advances in stress analysis, metallurgy and nondestructive testing, the weight of metal in a given part has been greatly reduced. No inspection method is 100% efficient and two or more methods are often used in conjunction with each other. Magnetic particle testing procedure is to establish a magnetic field on part to be tested and then apply a dry or wet powder. Surface and subsurface discontinuities show up on the surface. The depth of flaw causing discontinuity in field can be accurately estimated. The deeper the flaw the more fuzzy the outline. The fluorescent penetrant method is used for inspecting austenitic metals. Slides were used to demonstrate the effectiveness of magnetic particle and fluorescent penetrant methods of testing.

POWER SOURCES FOR WELDING

Miami, Fla.—G. K. Willecke (AWS), physicist for the Miller Electric Manufacturing Co., Appleton, Wis., was the guest speaker at the regular monthly dinner meeting of the *South Florida* Section held on April 18th at the Republican Club. His subject was "Power Sources for Welding." Mr. Willecke gave a most excellent and interesting talk on d-c rectifiers, how they are made, operated and maintained; also to what extent they can be used in the welding field.

PANEL DISCUSSION

Syracuse, N. Y.—The April dinner and technical meeting of the *Syracuse* Section was held in the Hiawatha Room of the Hotel Onondaga on April 11th.

The regular dinner speaker for this meeting was replaced by the "64,000 Point Program" which was set up along the lines of the TV program "The $64,000 Question."

BERNARD

PIONEER FOR MODERN WELDING

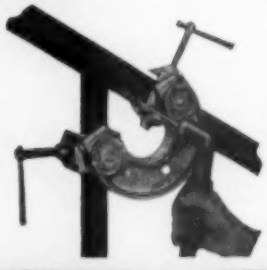
"Shortstub" ELECTRODE HOLDER

The jaws substitute for stub waste by splicing a 2 inch extension to the length of every electrode.

"Multi-Pic" CONTOUR CLEANER

Delivers FIVE surface cleaning blows with each swing and lasts FIVE times longer than single headed hammers.

"Pro-Clamp" MECHANICAL HANDS



MODERNIZE the fabrication of plates, shapes, rods, bars, pipes, etc. MAKE fitting, positioning, holding, and welding a fast, accurate, inexpensive, one-man job.

Mfg. by

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Master of ceremonies was Clarence E. Jackson AWS, district director, who was ably backed up by Ed Strand, chairman of the Section.

The contestants represented their Sections as follows: Olean-Bradford, M. H. Robinson, P. Stern, H. E. Rogers; Rochester, H. Stoler, R. Waldvogel, M. Kenney; Niagara Frontier, F. J. Weiss, L. Smith, G. E. Claussen; and Syracuse, L. H. Hawthorne, H. Wolfe, S. Strough.

The contest judges were: Olean-Bradford, F. Schnable; Rochester, N. N. Martin; Niagara Frontier, W. L. Burch; and Syracuse, R. Larkin.

The panel discussion was very lively and informative with the audience taking a very active part. The Rochester Section team of experts emerged the winner of the evening, but only after a hard struggle in which the leadership in points changed hands several times.

PROGRESS OF WELDING

Toledo, Ohio.—The April meeting of the *Toledo* Section was held at the Maumee River Yacht Club on April 17th. Speaker for the evening was Charles Herbruck AWS, Assistant to the Secretary of the Lincoln Electric Co. Mr. Herbruck discussed the progress of welding from its earliest stages as related in the Bible up to the present day. He offered patents as proof that the early progress of welding was strictly by guess and search, and how today we finally feel reasonably sure that we understand welding and can predict the properties of a completed weldment. Mr. Herbruck outlined the foreseeable future in the welding field and showed that the surface has merely been scratched.

SOLDERS AND FLUXES

Worcester, Mass.—Kenneth V. Lutz AWS, general sales manager of the All State Welding Alloys Co., White Plains, N. Y., was the guest speaker at the April 2nd meeting of the *Worcester* Section held at the Hickory House (Greendale).

Mr. Lutz confined his remarks to progress in alloys and fluxes for joining aluminum. He covered the alloy composition of a number of solders compatible with the several aluminum alloys available to the trade today. He explained the type of fluxes, where to use them, and where it is preferable to use the mechanical tinning method. He stressed the need of speed in bringing up the heat, so that the active ingredients in the flux do not become dissipated and ineffective before the base metal is warm enough for the solder to flow. He told of two new solders in the medium temperature range, one of which has a working temperature of 740° F and the other 600° F. He stressed the use of judgment in sizing up a job, thickness of pieces to be joined, heat dissipation, etc.

ATTENTION

AUTHORS FOR 1957 AWS NATIONAL SPRING MEETING

Authors who plan to propose papers for the 1957 National Spring Meeting in Philadelphia are informed that the necessary application forms are now being processed for distribution. Abstracts, consisting of not less than 500 words, must be submitted to AWS National Headquarters prior to Aug. 15, 1956, if they are to receive consideration. If needed, additional copies of application forms may be obtained by writing to National Secretary Joseph G. Magrath, AMERICAN WELDING Society, 33 W. 39th St., New York 18, N. Y.

Tempilstik° FOR ALL HEAT-DEPENDENT OPERATIONS

looks like a crayon... marks like a crayon... tells temperatures like a precision instrument!

Available in these Temperatures (F.)

113	375	1000
125	388	1050
138	400	1100
150	413	1150
163	425	1200
175	438	1250
188	450	1300
200	463	1350
213	475	1400
225	488	1450
238	500	1500
250	538	1550
263	600	1600
275	650	1650
288	700	1700
300	750	1750
313	800	1800
325	850	1850
338	900	1900
350	950	1950
363		2000

Sixty-three different compositions enable you to determine and control working temperatures from 113° to 2000° F.

TEMPILSTIK° marks on workpiece "say when" by melting at stated temperatures — plus or minus 1%.

ALSO AVAILABLE IN LIQUID AND PELLET FORM . . . WRITE "WELDING SALES" DEPT. FOR SAMPLE TEMPIL° PELLETS . . . STATE TEMPERATURES OF INTEREST—PLEASE!

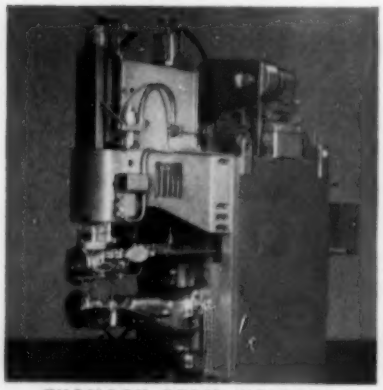
Tempil° CORPORATION 132 WEST 22ND STREET, NEW YORK 11, N. Y.

THOMSON

HANDLE RECEIVERS are attached to stainless steel pans — a typical projection welder application. Result: high production, low unit cost, strong welds, no marring of high finish.

NEW SPOT WELDERS

Model RA Spot Welders extend the complete line—provide low cost equipment for utility or production work.



THOMSON SEAM WELDERS

Sizes range from 50 to 400 KVA. Models for circular, longitudinal or universal seaming to exacting specifications.

"SYNCHRO-MATIC" FLASH WELDERS

This exclusive THOMSON development has set new standards for flash-butt welding nonferrous as well as ferrous metals.

specialists in the broad field of RESISTANCE WELDING EQUIPMENT

The THOMSON line is truly complete — ranging from simple, low cost, standard machines to highly specialized production welding equipment. It includes all standard resistance welding types — spot, projection, seam and flash-butt — as well as electro-brazing, electro-forging, upsetting and related equipment.

THOMSON also offers complete engineering, laboratory and experimental facilities to help develop the most effective welder for any application — plus an organization of capable representatives in all metalworking centers to make this service conveniently available to you.

Keep THOMSON in mind when you need resistance welding equipment, technical assistance or the recommendations of the foremost resistance welding specialists.

FOUNDED IN 1900 BY ELIHU THOMSON

INVENTOR OF RESISTANCE WELDING

THOMSON *Welders*

THOMSON ELECTRIC WELDER COMPANY, LYNN, MASS.

WIRE FABRIC WELDERS

Typical of the many special THOMSON designs which have become standard in their fields of application.

SPECIAL PURPOSE WELDERS

Designed to do one job in the most effective, economical way. Automation applied to resistance welding.

New Members

Effective April 1, 1956

MEMBERSHIP CLASSIFICATION

A—Sustaining Member B—Member C—Associate Member

D—Student E—Honorary Member F—Life Member

Total National Membership April 1, 1956

Sustaining Members	*125*
Members	*5,393*
Associate Members	*5,726*
Student	*219*
Honorary Members	*9*
Life Members	*16*
Total	**11,488**

Grow With AWS!

ALBUQUERQUE

Sparks, Paul S. (B)

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Arms, Elvin N. (B)
Decker, John R. (B)
Nunley, Lee (B)
Redman, Don (C)

BOSTON

Atlas, Elliott J. (C)
Bourque, Frances (B)
Brady, Arthur J. (B)
Capano, Salvatore (C)
Crawford, Allyn S. (C)
Fersoco, Pasquale (C)
Hanson, Walter E. (B)
Lawrence, Irving L. (B)
Lusardi, Anthony G. (C)
McKeon, Edward J. (C)
Menslage, William H. (C)
Moore, C. D. (C)
Nugent, John J. (B)
Pooler, Elmer E., Jr. (B)
Rendell, Leroy G. (B)
Rogers, Donald A. (B)
Wolejko, Charles H. (B)

CHICAGO

Cameo, Robert M., Sr. (C)
Fragalle, Paul J. (C)
Heyl, Lawrence (B)
Iverson, Einar (C)
McCorkle, Lee R. (C)
Orr, Robert C. (B)
Strempka, Leonard V. (B)
West, J. T. (B)

CLEVELAND

Anderson, Harold G. (C)
Baer, John W. (C)
Cowgill, Charles (C)
Diezman, Charles R. (C)
Geil, Gus Wm. (B)
Gluvna, William R. (C)
Morse, William J. (C)
Strohl, Orval A. (C)
Suhart, Edward R. (C)

COLORADO

Heckendorn, James P. (B)
Iannacito, Edward P. (C)
Lambrecht, A. A. (C)
Schmidt, Augustin (C)

COLUMBUS

Fields, J. J. (B)
Gregg, Max (B)
Lindsay, Robert E. (B)
Lutz, James C. (C)
Rugh, Robert E. (B)
Smith, Frank D. (C)

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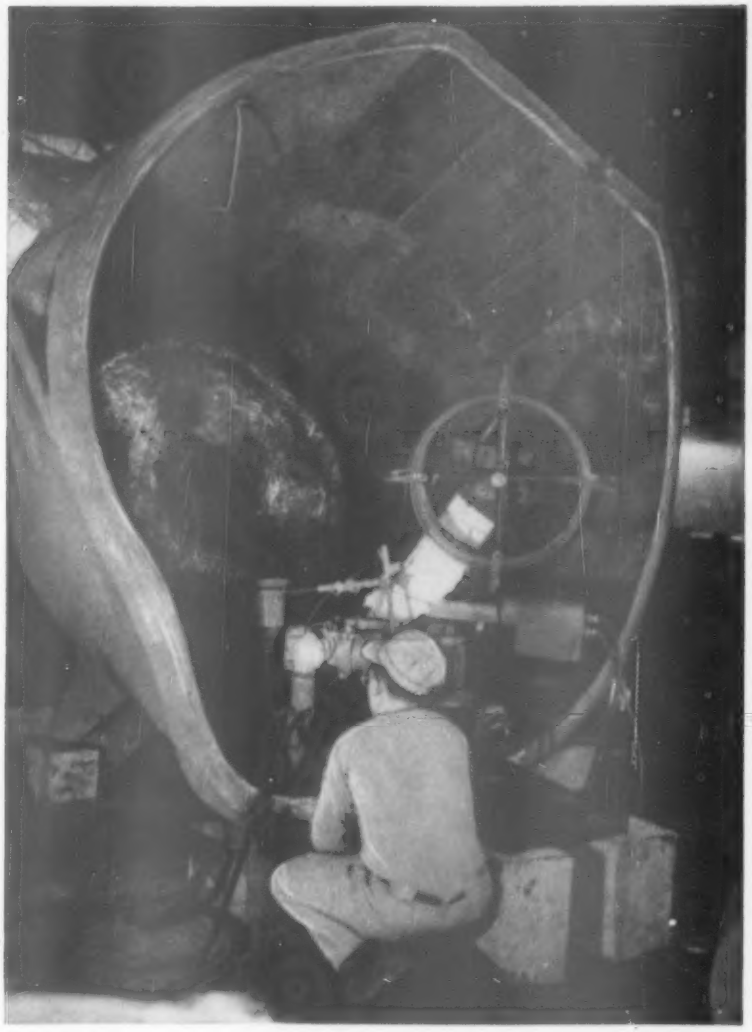

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ABSTRACTS OF CURRENT PATENTS

prepared by Vern L. Oldham

Printed copies of patents may be obtained for 25¢ from the Commissioner of Patents, Washington 25, D. C.

2,739,369—Method of Making Electrical Contacts—James S. Cooney, Attleboro, Mass., assignor to Metals & Controls Corp., Attleboro, Mass., a corporation of Massachusetts.

This method relates to the forming of composite electrical contacts and comprises the steps of placing cleaned surfaces of a first malleable contact face metal and a backing metal therefore together and providing a second pair of such contact face metal and backing metal assemblies. The pairs of members are placed together with a parting layer therebetween after which the pairs of members are forced toward each other to cause an outward flowing of the contact face metals and backing metals at the junctions of the cleaned surfaces. This action is continued until the cleaned surface of each contact face metal becomes cold welded to the cleaned surface of its mating backing metal in many discrete spots.

2,739,375—Joining of Nonmetallic Materials and Brazing Filler Rods Therefor—Charles D. Coxe, Fairfield, Conn., assignor to Handy & Harman, New York, N. Y., a corporation of New York.

This patent relates to making a brazing alloy joint between two surfaces, at least one of which is nonmetallic. Initially the brazing composition containing an active metal such as titanium, which forms the core of the composition and which has a sheath of ductile metal thereabout, is placed in proximity to the surfaces to be brazed together. The ductile metal in the sheet is capable, when molten, of dissolving the active metal of the core in the amount of at least 1% of the weight of the sheath metal to form an alloy capable of wetting nonmetallic materials. Heat is applied to the brazing composition to melt some of the sheath metal and form a molten body thereof, and the brazing composition is held in contact with such molten material until an amount of the active metal has been dissolved and formed an alloy which wets the surfaces to be brazed together. The molten body of metal is maintained in an atmosphere substantially inert to such molten material.

2,740,034—Precision Article for Electric Resistance Projection Welding—William J. Carlyle, Barrington, Ill., assignor, by direct and mesne assignments, to Richard J. D. Heilshorn, Chicago, Ill.

This patent discloses an article for electric resistance projection welding wherein a body portion is provided and it has projection welding means extending forwardly therefrom. Special cavity means are provided in the body portion and have a shape generally the same as the shape of the projection welding means. The cavity also has a volume not less than the volume of the projection welding means.

2,740,044—Resistance Welding Monitor Control—Herbert F. Storm, Schenectady, N. Y., assignor to General Electric Co., a corporation of New York.

This patent covers a special control circuit usable in welding actions. The circuit particularly includes means responsive to a predetermined percentage drop in the value of an electric quantity and an electric oscillator for measuring a change in the electric quantity by a proportional change in its frequency of oscillation. Other specialized circuit means are disclosed in the patent.

2,740,876—Hollow Article Welding Apparatus—Frank J. Zoschg, Sinnemahoning, Pa., assignor to Sylvania Electric Products, Inc., a corporation of Massachusetts.

A specialized welding apparatus is covered in the present patent and it includes a pair of electrodes that can be positioned in association with a hollow elongated article. The electrodes can be moved substantially perpendicularly to the axis of the elongated article to have one electrode overlying such article. Other means move another of the electrodes across an end edge of the article and into the hollow of the article to a position in registration with the first electrode overlying the article.

2,740,877—Welding Apparatus—John P. Knauth, Skaneateles, and Kenneth R. Lang, Liverpool, N. Y., assignors to Syracuse Special Machine Co., Inc., Syracuse, N. Y., a corporation of New York.

In this seam welding machine, a pair of parallel, oppositely directed rows of narrow clamping fingers are provided and a stationary horn member is located centrally below such rows of fingers. A pair of backing members are slidably mounted on the horn member, with each backing member being independently movable upwardly toward one of the rows of fingers to coact therewith in clamping a workpiece in seam welding position.

2,741,024—Method of Joining All-Metal Hose by Resistance Welding—Robert Breuer, Lucerne, Switzerland, assignor to Metallschlauchfabric A.G., Lucerne, Switzerland.

Breuer's patent relates to the securing of a metal hose having corrugations thereon to a tubular member. Initially the corrugations on the hose end portion are flattened to form a smooth, cylindrical hose end portion coaxial with the corrugated metal hose. An end of a tubular member is inserted into this smooth, cylindrical hose end portion and an annular seam is formed between the members by electric resistance welding while holding the surfaces of the members in tight contact.

2,741,688—Welding Electrode—Harold A. Johnson, Milan, Ill.

This patented welding electrode includes a holder having a fluid passage therein. Special fluid circuit forming means and sealing means are also provided in the holder to complete the fluid circuit therein.

2,741,689—Tungsten Backing Bar—John A. Persson, Kenmore, N. Y., assignor to Union Carbide and Carbon Corp., a corporation of New York.

This patent is on a method of arc welding comprising supporting the work on a backing bar of a refractory metal extending beyond the work at the front and rear ends thereof, an arc is struck between an electrode and the projecting front end of the refractory bar ahead of the work, and relatively moving the arc and the work along the seam above the refractory bar to effect the weld. The arc is continued in its travel beyond the work onto the projecting rear end of the refractory bar before the arc is extinguished.

2,741,832—Method of Forming A Smooth Welded Seam—Burt F. Raynes, Chula Vista, Calif., assignor to Rohr Aircraft Corp., Chula Vista, Calif., a corporation of California.

This patent is upon a method of forming a smooth welded seam in a longitudinally split tube blank comprising the steps of abutting the edges in the metal tube blank and holding the ends of metal tabs against the metal tube blank at both ends thereof. The metal tabs are welded to the ends of the tube to provide tab portions projecting outwardly from the ends thereof and to hold the abutting edges of the tube blank together. Then such abutting edges are welded together by a continuous seam extending the length of the tube. The tabs and seam on the tube are then passed through a pair of rolls while applying pres-

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2,742,552—Apparatus for Electric Resistance Welding of Scaly Metals—Joseph J. Riley, Warren, Ohio, assignor to the Taylor-Winfield Corp., Warren, Ohio, a corporation of Ohio.

In the patented welding apparatus, a combination is covered providing a pair of electrodes and buss conductors leading to the electrodes. A dry disk rectifier bank is connected at its output terminals with the conductors, and a welding transformer connects with the input terminals of the rectifier bank. A second transformer is provided and includes a primary coil. The conductors and electrodes, and other means present, provide a highly inductive coupling between the coil and the conductors and electrodes. Shunt means are positioned between the output terminals and the coil to short circuit such output terminals during energization of the coil. A source of alternating current energy is provided for sequentially energizing the coil and then the transformer.

2,742,553—Submerged-Arc Welding Method and Apparatus—Amel R. Meyer, Griffith, Ind., assignor to Graver Tank & Mfg. Co., Inc., East Chicago, Ind., a corporation of Delaware.

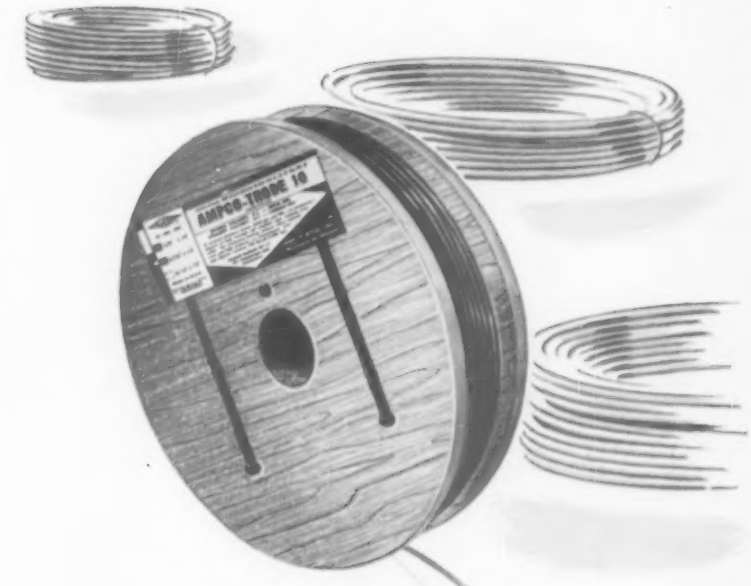
Meyer's patent relates to a welding process for use on an upright seam. The process includes the steps of rolling a slightly dished flux support member against the seam to expose an upwardly concave surface and pouring flux onto such surface to provide a core mound so that portions of the flux run over the side of the member. A welding electrode is fed to the seam and a flux support member is upwardly traversed along the seam so that successive portions of the member are rolled on to upwardly successive portions of the seam.

2,742,554—Welding Head Mount—Clifford M. Westfall, Homewood, Ill., assignor to Chicago Bridge & Iron Co., a corporation of Illinois.

This patent relates to a welding machine having a chassis and depending framework for carrying welding equipment along a generally horizontal joint between upright plates. A weld-head mount is provided and comprises a pair of generally horizontal guide bars secured to the framework of the machine and a weld-head supporting member secured to the guide bars for movement therealong.

2,742,555—Flame Boring Apparatus—Robert W. Murray, Denver, Colo.

A gas-arc flame boring apparatus is covered in this Murray patent and it includes a drill stem having a passageway extending longitudinally therethrough. A pair of electric conduits extend longitudinally through the stem, which conduits are insulated from each other, but arranged to provide an arc at one end of the stem. A head at the other end of the stem has connection means provided thereon for supply of gas thereto and has terminal means for connection of power supply leads in circuit with the electrical conduits.



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PERSONNEL

Slottman Awarded Morehead Medal

The Morehead Medal was presented to G. V. Slottman, vice-president, research and engineering, Air Reduction Co., Inc., by the International Acetylene Assn. during their 56th Annual Convention in Los Angeles, Calif., Mar. 12–14, 1956, at the Hotel Statler.

G. V. Slottman

The Morehead Medal, in its 30th presentation, was awarded to Dr. Slottman for his scientific contributions to carbide, acetylene and oxygen technology.

Formal presentation of the medal was made by E. A. Daniels, director and past president of the International Acetylene Assn. and vice-president of Victor Equipment Co., San Francisco.

The Morehead Medal is awarded annually by the International Acetylene Assn. to the person or persons who in the judgment of its officers and board of directors have done most to advance the industry or the art of producing or utilizing calcium carbide or its derivatives.

Pluhar Appointed by Warnock Hersey

The Warnock Hersey Co. Ltd. announces the appointment of A. J. Pluhar as Manager of its Nondestructive Testing Division, with headquarters in Toronto.

Mr. Pluhar received his degree in Civil Engineering from the University of Prague in 1931, and has had many years of experience in engineering, and in managing the research and practical application of welding and nondestructive testing techniques. His work has been undertaken in Europe and in many other parts of the world, and in Canada since 1950.

He is a member of the American Welding Society, the Association of Professional Engineers of Ontario, as well as being active in many societies devoted to engineering and other technical processes, in Canada, the United States, England and Switzerland.

Mathey Promoted

H. C. Mathey has been promoted to Vice-President in charge of Sales of the Liquid Carbonic Corp. Mr. Mathey, a graduate of Lafayette College, has been with Liquid Carbonic for thirty years. During that time he has had very wide experience in the company's Compressed Gas Divisions.

Prior to assuming his new duties, Mr. Mathey was Vice-President in charge of the Pacific Coast Operations.

Brandt Joins Precision Welder

The appointment of Frank Brandt as exclusive representative in New England is announced by Precision Welder and Flexopress Corp. of Cincinnati, Ohio. Mr. Brandt will be assisted in Connecticut by Robert E. Browne who has been in New England for Precision for four years.

Frank Brandt

Mr. Brandt was formerly Chief Electrical Engineer and Sales Manager for Thomson Electric Welder Co.

Past Chairman and Director of the Boston Section of the American Welding Society, Mr. Brandt has been a member of numerous national committees of AWS as well as the Welding Research Council Sub-Committee, Electric Welding Committee of the American Institute of Electrical Engineers, and Resistance Welder Manufacturers Assn. Technical Committees in joint work with NEMA, JIC and Military Specifications.

Mr. Brandt's office is located at 56 Jasper, Saugus, Mass.

Keller Appointed Chief Engineer

The appointment of Robert G. Keller as chief engineer has been announced by the Machine Division of The Lewis Welding & Engineering Corp., Bedford, Ohio.

A graduate of Case Institute of Technology, Mr. Keller will be in charge of an integrated engineering department responsible for design and development work on Lewis proprietary machines, special machinery and automation equipment.

BOUND VOLUMES OF 1955 JOURNAL NOW AVAILABLE

Bound Volumes of The Welding Journal for the year 1955 are available in black imitation leather covers, together with a comprehensive subject and authors index. Price $15, including postage.

This volume, comprising a total of 1260 pages in the Journal and an additional 624 pages in the *Welding Research Supplement*, represents a veritable encyclopedia of information in the welding field. Copies may be ordered through the American Welding Society, 33 W. 39th St., New York 18, N. Y.

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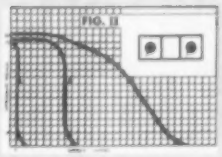

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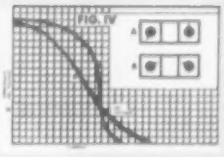

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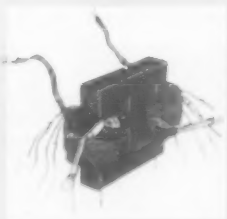

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NEWS of The Industry

Independent Distributors to Meet in San Diego

The Annual Meeting of the Independent Welding Distributors Assn., Inc., will be held on June 21st and 22nd in San Diego, Calif. Members and their families will stay at the Kona Kai Club in San Diego.

New business for the coming year will be discussed as well as the election of new officers.

Hosts for this meeting are the Bailey Equipment Co. and the Pacific Acetylene Co., both of San Diego, Calif.

RWMA Members Report Continued Record Business

The monthly statistical information compiled by the Resistance Welder Manufacturers Assn. again indicates substantial increases in the recently tabulated March data.

For the third consecutive month, new orders obtained by members exceeded 5½ million. New business for the first three months of 1956 when compared with the same period last year, shows an outstanding gain of 116%

Shipments during the same three months reflect an increase of 24% over the first quarter of 1955. The nearly $4 million in shipments in March represents a record volume in the many years of Association reports.

Members of RWMA also report an all-time record backlog of orders on hand at the end of March of considerably in excess of $20 million.

Ampco Metal Appoints Distributors

Several new distributors have been appointed by the Resistance Welding Department of Ampco Metal, Inc., Milwaukee, Wis. They are: Keenan Welding Supplies Co., Inc., P. O. Box 1927, Albany, Ga.; Metz Welding Supply Co., 1500 W. Hopkins St., Milwaukee, Wis.; Miami Welding Supply, Inc., 3016 N. Miami Ave., Miami 37, Fla.; Frank Brandt, 56 Jasper St., Saugus, Mass.; Moehlenpah Engineering, Inc., 501 Garver Bldg., Des Moines, Iowa.

The new distributors will handle the Ampco-Weld line of electrodes and accessories.

Fusion Engineering Expands

Production of paste solders and brazing alloys is expected to be increased by 35% in the new plant completed by Fusion Engineering at 17921 Roseland Ave., East Cleveland, Ohio.

The greater production facilities are designed to enable the development of new paste alloys beyond those already serving specific requirements. Each paste alloy, a chemical blend of solder, flux, cleaning and tinning agent, is designed to be placed in the joint area during assembly. Brazing or soldering can then proceed automatically.

Steel Industry's "Birthplace" Open for Season

The Saugus Ironworks Restoration, 300-year-old "birthplace" of America's iron and steel industry, opened its 1956 tourist season on Tuesday, April 17th.

Rebuilt in a picturesque setting along the banks of the winding Saugus River, the colonial ironworks is located just east of U. S. Route 1, 10 miles north of Boston. Last season, 17,500 persons coming from every state and 13 foreign countries visited this shrine to one of America's great industries.

Although built more than 130 years before the American Revolution, the original Saugus Ironworks was a modern plant for its time and was considered the industrial wonder of the day. Operating from about 1646 to 1670 the pioneer ironworks produced much of the iron needed for a fast growing country.

The Saugus Ironworks was rebuilt in 1954 by the American iron and steel industry to dramatize the historical and educational significance of the pioneer plant. More than $1,500,000 went into the research and reconstruction to make the ironworks an authentic reproduction of the original.

Entering the gates of the Restoration today, the visitor sees the ironworks just as it appeared in 1650. High on a hill framed against the sky stands the quaint Ironmaster's House furnished with period pieces including many priceless antiques. A few steps from the house is the ironworks' museum where relics unearthed by the archeological crew during the excavations are on permanent display. Also in the museum are colorful exhibits tracing the growth of our iron and steel industry from the Saugus Ironworks.

On the banks of the Saugus River is the ironworks itself, recreated in every detail. Key structure is the stone blast furnace built with many of the stones used in the original furnace. Nearby is the forge building where cast-iron bars from the furnace were reheated and refined into wrought iron. A short distance away is the rolling and slitting mill where wrought iron bars were rolled into "flats" or cut into rods which were bought by local farmers and blacksmiths for making nails. A few yards from the slitting mill is a ware-

COMING EVENTS

A Calendar of Welding Activity

AWS National Meetings

1956 Fall Meeting:
Oct. 8–12, Cleveland Hotel, Cleveland, Ohio

IWDA

June 21–22, Annual Meeting, San Diego, Calif.

NWSA Zone Meetings

Sept. 20–21, Hotel Statler, New York City

Sept. 24–25, Hotel LaSalle, Chicago, Ill.

National Metals Exposition:

Oct. 8–12, Thirty-eighth National Metal Exposition and Congress, Cleveland Public Auditorium, Cleveland, Ohio

house and a wharf where boats would load the iron for shipment to Boston, to colonies along the coast and to overseas customers.

Although no iron is made today at the Saugus Ironworks Restoration much of the ironworks is operative, making it a favorite subject for visiting photographers. Water rushes along wooden troughs to turn the plant's seven water wheels which in turn operate massive leather bellows, the giant forge hammer and the complex rolling and slitting machinery. Smoke rising from the ironworks' chimneys lends added realism to the scene.

The Saugus Ironworks Restoration will be open from 9 A.M. to 4 P.M. daily, except Mondays, from April 17th through Nov. 30, 1956. Admission is 50 cents for adults, 25 cents for children. Trained guides explain how the ironworks operated and answer visitors' questions.

Jersey Welding Expands

Joseph B. Lyons, of Jersey Welding Supply, Inc., Plainfield, N. J., announces the acquisition of the Brunswick Oxygen Co., New Brunswick, N. J. The latter will continue to operate under the same name.

Mr. Lyons is a member of the AMERICAN WELDING SOCIETY.

Nelson Appoints Distributor

The appointment of the Tulsa Welding Supply Co., 2435 E. Independence St., as distributor in the Tulsa area for the Nelson Stud Welding Division, Gregory Industries, Inc., Lorain, Ohio, has been announced by the latter company.

Stud welding guns, Nelwelder generators and portable battery sources will be available for purchase or rental through Tulsa Welding Supply.

Meco Appoints May

Modern Engineering Co., St. Louis, Mo., announces the appointment of David D. May as Factory Sales Representative for its Meco Oxy-Acetylene Welding and Cutting Apparatus Divisions.

Mr. May will contact distributors in the South Central States and will make his headquarters in Memphis, Tenn.

Gasflux Relocates

The Gasflux Co. announces that it has moved its plant, general offices and principal sales office to new and larger quarters at 141 N. Logan St., Elyria, Ohio, where improved facilities will better accommodate the firm's activities. Gasflux Co. was formerly located in Mansfield, Ohio.

M & T Acquires Glenn Co.

As another step in its current expansion program, Metal & Thermit Corp. has acquired the Glenn Co., Oakland, Calif., makers of constant voltage power sources, welding wire feeding devices and other products. The business is being moved to new quarters at 703 37th Ave., Oakland, where it will be operated as a manufacturing subsidiary under the name M & T Welding Products Corp.

The constant voltage welding machines acquired from Glenn by M & T are used as the power source in semi-automatic and automatic welding processes, including inert gas, submerged arc and metallic arc.

Officers of the newly formed M & T Welding Products Corp. are: H. E. Martin, president; G. G. Glenn, E. E. Anderson and J. L. Oberg, vice-presidents; J. F. Condon, secretary and C. J. Beasley, treasurer.

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NEW PRODUCTS

Flame Cut-off Machine

A new flame cut-off machine has been announced by Speedi-Burn Products Co., Inc. Versatile in operation, the machine performs straight cut-off and beveling operations on medium- and large-diameter bar stock and pipe.

For pipe cut-off operations, the torch is mounted radially, and in operation, describes a complete revolution about the work. For bar stock cutting, a "secant" action of the torch is used, with the torch head describing only part of a revolution.

For further information on this new flame cutting equipment, write to Speedi-Burn Products Co., Inc., 534 Linden St., West Hempstead, N. Y.

Build-Up Electrode

A foundation material for building up carbon steel parts preliminary to hard facing is now available in a low-cost build-up electrode. The new electrode is alloyed to resist plastic deformation, upset and overroll.

According to its manufacturer, All-State Welding Alloys Co., Inc., 249–55 Ferris Ave., White Plains, N. Y., a-c or d-c deposits from the electrode exhibit 30 Rockwell C hardness and cannot be machined or forged unless preheated to 400° F or red heat, respectively.

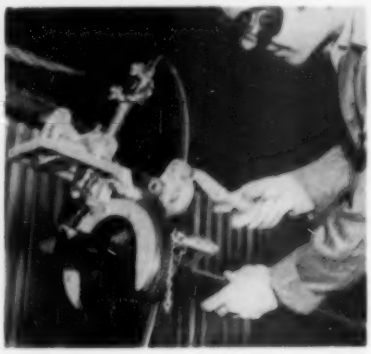
Name of the new electrode is Roll Matrix. It is inherently wear resistant but is not classed as a hard-surfacing rod. It is made for application as the first step in retreading carbon steel parts which have become excessively worn.

Steels containing 0.35 to 0.90% carbon, including those alloyed with chromium, nickel, molybdenum, etc., can be rebuilt.

Complete details may be had by writing directly to the manufacturer.

Pipe Cutter

Introduction of a completely portable flame cutting and pipe beveling machine for small-diameter pipe ($1^1/_2$ to 4 in.) has been announced by the H & M Pipe Beveling Machine Co. of Tulsa, Okla. The new unit is expected to have wide application in many new industries, especially where the fabrication and use of small-diameter piping is an important factor. The



smaller machine is constructed on the same design principles as larger H & M models, and patents have been applied for on certain features.

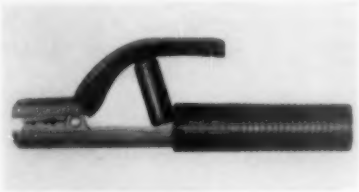
According to the manufacturer, changing the unit from one size of pipe to another is a matter merely of replacing precision-made adapters, properly identified for the various pipe sizes. The change from the smallest to the largest pipe size can be made in a matter of seconds. Any plain-barrel machine cutting torch may be used with the unit.

For complete details, write directly to the company at the above address.

Lightweight Electrode Holder

A new, lightweight arc welding electrode holder has been announced by Tweco Products, Inc., of Wichita, Kan. Called the No. AL-300 Tweco-tong, the new holder has a body and upper lever made of high conductivity aluminum forgings. The new holder weighs just $13^1/_2$ oz which is a reduction in weight of about 50% under conventional holders made of copper castings.

According to the manufacturer, the forging of the metal parts gives the holder high-tensile strength and increases the conductivity to a point where it surpasses copper castings. Both



the upper and lower replaceable jaws of the holder are made of pure copper and are cadmium plated to resist corrosion and to prevent weld spatter sticking to the jaws. All parts of the holder are replaceable.

The welding cable is easily attached to the holder by baring the cable end and inserting it in the reamed hole in the holder body. One large ball point Allen screw holds the cable securely in place and makes an excellent electrical connection. The holder can be installed on a cable in less than two minutes.

Complete details may be had by writing directly to Tweco Products, Inc., P. O. Box 666, Wichita 1, Kan.

Solder Microforms

A series of solder microforms, with rare metal elements that range in purity to 99.999 plus, has been introduced by the Anchor Metal Co., Inc., 244 Boerum St., Brooklyn 6, N. Y.

These solder elements include indium, gallium, selenium, tellurim, gold, platinum, silver, aluminum, arsenic, antimony, bismuth, cadmium, copper, tin, zinc and lead.

For complete details, write directly to the company.

Nickel-Aluminum Bronze Spooled Wire

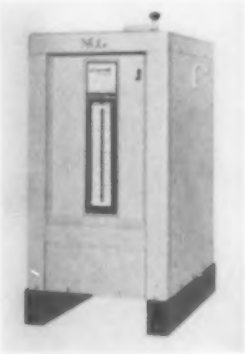
Ampco-Trode 46 is a new, patented, nickel-aluminum bronze electrode of special composition for the welding of nickel-aluminum bronze cast ship propellers and turbine runners in spooled form for use with the inert-gas consumable-electrode process.

It is available in 0.045, $^1/_{16}$, $^5/_{64}$, $^3/_{32}$ and $^1/_8$ in. diam sizes on either spools or rims for inert-gas metal-arc welding. It can also be supplied as coated electrodes for metal-arc, coated 36-in. filler rods for carbon-arc and 36-in. bare filler rods for inert-gas tungsten-arc welding.

For additional information, write to Ampco Metal, Inc., Milwaukee 46, Wis.

Arc Welder Line

An expanded and improved line of Sureweld arc welders has just been announced by the National Cylinder Gas Co., Chicago, Ill.



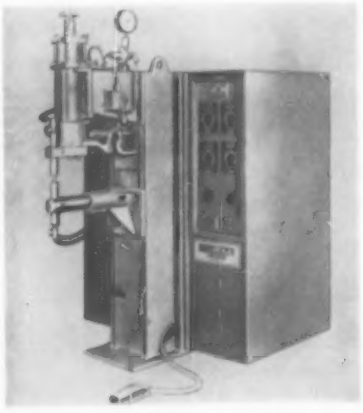
Included in the line—numbering 10 different types and 98 models—are a-c welders, d-c rectifier welders, a-c inert arc welders, combination a-c, d-c welders, and portable engine-driven d-c welders.

NCG will also offer a complete line of automatic control units, remote control devices, switches, high-frequency units, water-coolant mechanisms and other accessories which, according to the company, will permit modifications of basic welder installations to fit virtually any specialized welding requirement.

Complete catalog information on the new Sureweld line of arc welders and accessories is available from National Cylinder Gas Co., 840 N. Michigan Ave., Chicago 11, Ill.

Spot and Projection Welder

Sciaky Bros., Inc., 4915 W. 67th St., Chicago, Ill., announce the new designs of a standard, air-operated, press-type spot welder (SPT 1) and projection welder (EPT 1). With the exception of the actual welder applica-



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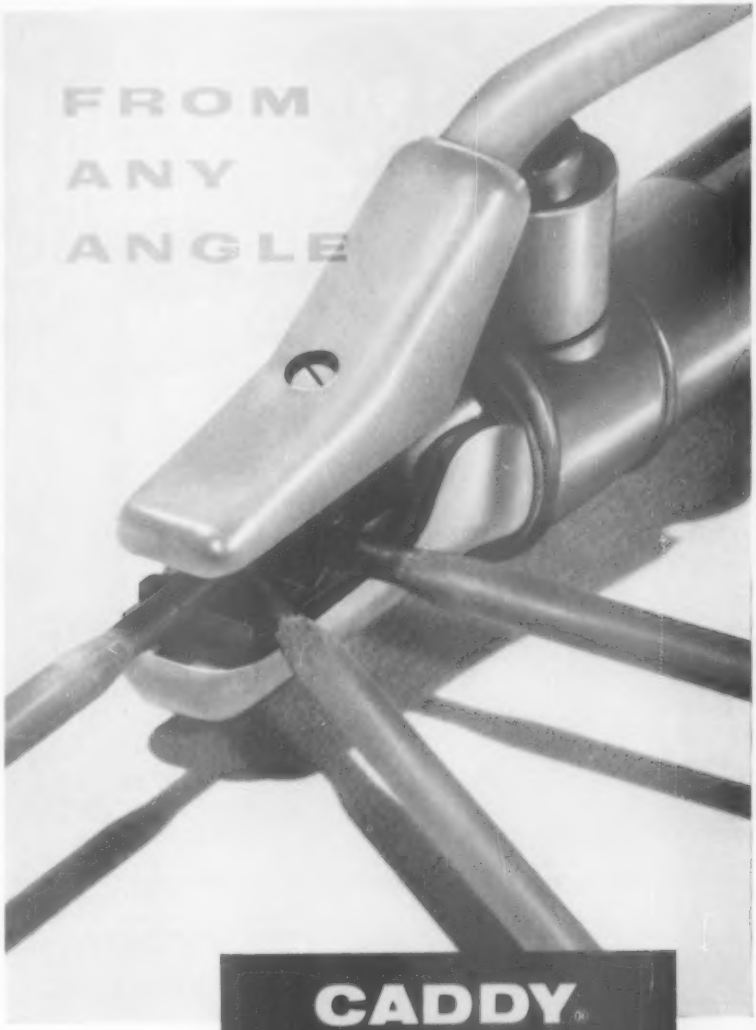

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tion of electrode arrangement, both machines are the same.

These welders are number one of a series of sizes ranging 1 through 5. Available in 40- and 75-kva rating at 50% Duty Cycle. SPT 1 throat depths range 18, 24, 30, 36 and 42 in., while for the EPT 1, they are 12, 18, 24 and 30 in. The shortest throat depth of both machine types will accommodate a maximum electrode force of 1575 lb at 80 lb gage.

The SPT 1 and EPT 2 are designed to weld a wide range of mild steel, stainless steel, aluminum and other light alloys to commercial standards.

For more complete information about the SPT 1 and EPT 1, write Public Relations, Dept. M-9 at the Chicago address, requesting Bulletin 335-1.

Automatic Inert-Arc Welding Equipment

Air Reduction announces that its new Model C Heliweld automatic head provides a completely automatic weld cycle. A single switch causes the holder to move downward and start the arc, and the arc length is maintained constant throughout the weld. Equipment is designed for inert-gas tungsten-arc welding of light gages of

stainless steel, mild steel, aluminum brass, copper, titanium, beryllium, Everdur, nickel, Inconel and Monel.

Electronically controlled, this new Airco Heliweld unit is primarily designed for d-c inert-arc welding with argon or helium shielding gases, or a mixture of the two. It can also be used for a-c inert-arc welding with the Airco Heliwelders or the Airco Heliweld Bumblebee Arcwelder (when a-c adapting equipment is added).

Additional information about this new Airco Heliweld head may be obtained by writing Air Reduction Sales Co., a division of Air Reduction Co., Inc., 60 E. 42nd St., New York 17, N. Y.

SWITCHED TO A-S No. 13
Company Processing Sugar Beets

They Switched to Nickel-Silver for Retreading with Wear-Resisting Build-Up Metal!

They spent $23.74 *more* for 100 lb. of Nickel-Silver . . . *saved* $150.50 in other costs incident to repair of this one spindle. They repeated on 8 spindles. All-State No. 13 Nickel-Silver Build-up Rod is now their standard for retreading.**

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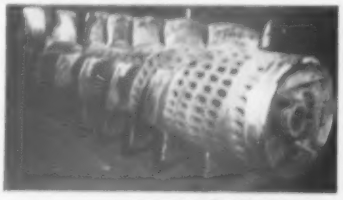
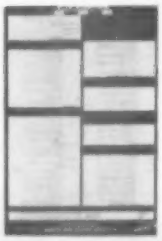
10 lb. No. 13 will start saving money for you. Comes bare or flux-coated.



**Details on request

FREE Ask for Buyers Guide. This is book full of product solutions to metalworking problems.



WALL CHART TO HELP YOU SELECT BEST FOR JOB FROM 86 ALL-STATE PRODUCTS

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19" x 22" Coated Paper

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ALL-STATE WELDING ALLOYS CO., INC., WHITE PLAINS, N. Y.

NEW LITERATURE

Abrasive Wheels

A booklet telling the story behind Bay State's new Electronic Formulation process is now available. Send for your free copy directly to Bay State Abrasive Products Co., Westboro, Mass.

Brazing News

The availability of the latest issue of their Bulletin *Low-Temperature Brazing News* is announced by Handy & Harman, 82 Fulton St., New York 38, N. Y. A free copy of Bulletin 72 may be had by writing to the above address.

Gas Manufacture

Single- and double-rectifications plants for the production of oxygen or nitrogen in gaseous or liquid form are described in a 20-page catalog just issued by Superior Air Products Co. of Newark. Liquid air plants and acetylene plants are also illustrated and described. Production data and flow diagrams are included for each type of plant.

For a copy of *Supairco* write to Superior Air Products Co., 132 Malvern St., Newark 5, N. J.

Ampco Welding News

The first quarter issue of the *Ampco Welding News* was recently released by Ampco Metal, Inc.

The feature article in this issue describes the use of Ampco-Trode 300 electrodes and the metal arc process in overlaying crimping rolls used in the forming of couplers and sprinkler outlets.

Free copies of this issue can be obtained by writing Ampco Metal, Inc., 1745 S. 38th St., Milwaukee, Wis.

Oxidizing Solution

Krembs & Co. have prepared a leaflet on their "Oxy-dyz-ene." A concentrated liquid oxidizing solution for oxidizing brass, copper, silver, etc.

Complete instructions are given for treating the various metals to produce different colors.

A generous sample will also be sent to those who request it by writing to Krembs & Co., 669 W. Ohio St., Chicago 10, Ill.

Resistance Welders

Precision Welder & Flexopress Corp. has published a new six-page bulletin covering its complete line of resistance welders. In addition to its standard and semistandard line of resistance welders, the bulletin describes Precision specials, designed and tooled to solve specific and unusual production problems. Write for Bulletin G-100, Precision Welder and Flexopress Corp., Cincinnati, Ohio.

Welding Accessories and Safety Equipment

A new 48-page comprehensive catalog published by the Fibre-Metal Products Co. covers welding helmets, hand shields, electrode holders, a weld testing machine, face shields and screens, leather and asbestos safety specialties, goggles, filter and safety glass, welding cable and lugs, chipping hammers, wire brushes. . .and many other welding and industrial safety products.

Additionally, a section of the catalog is devoted to suggestions as to the beneficial use of safety equipment.

This catalog (Catalog No. 24) may be obtained by writing the Fibre-Metal Products Co., Chester, Pa.

Safety Booklet on Grinding Wheels

A new 36-page booklet entitled "Mounted Wheels" has been issued by the Grinding Wheel Institute. This publication represents the first time that information on maximum operating speeds for this very important abrasive product has been available to the user of mounted wheels. Prior to issuance of the "Mounted Wheels" booklet, an operator was required to compute maximum operating speeds by using "critical speed" information. The eight easy-to-use "maximum speed" tables contained in the "Mounted Wheels" booklet are designed to facilitate user's correct application. They will eliminate the confusion which occurred when speeds other than safe maximum operating were listed.

The booklet contains rules for safe and efficient operation and information on standard sizes of mounted wheels together with standard mandrel sizes applicable for each.

Safety Hats and Caps

The Fibre-Metal Products Co. offers Bulletin No. 45 describing *SuperGard* Safety Hats and Caps molded of thermosetting, Fiberglas-reinforced, polyester resin. Their inner suspensions are quick-form-fitting, resilient polyethylene material, with no metal parts, quick-adjustable to any head size, according to the manufacturer. Because of their "all plastic" construction, only the leather sweatband ever needs to be replaced.

SuperGards come in nine colors. They meet Federal specification tests for impact, penetration, electrical resistance, flammability, water absorption and remain fully resilient. Bulletin No. 45 may be obtained by writing the Fibre-Metal Products Co., Chester, Pa.

Booklet on All-Welded Yacht

A 12-page booklet is available from Air Reduction which discusses the building of an all-welded 96-ft American built motor yacht. The article, by LaMotte Grover, Welding Engineer, Air Reduction Sales Co., and E. H. Holder, Welding Engineer, Ingalls Shipbuilding Corp., appeared originally in THE WELDING JOURNAL.

Structural design, construction features, prefabrication, subassembly, shell plate and superstructure erection and welding are some of the main subjects covered in the illustrated article.

A copy may be obtained by writing Air Reduction Sales Co., a division of Air Reduction Co., Inc., 60 E. 42nd St., New York 17, N. Y.

Weldability of Titanium

The effects of alloying elements on the weldability of titanium sheet are described in a report of research for the Air Force just released to industry through the Office of Technical Services, U. S. Department of Commerce.

This fundamental study, the report states, should help to enlarge and clarify the range of weldable titanium-alloy compositions. At the same time, heat treatments that will restore ductility after embrittlement by the welding cycle are described in terms of the individual phase relationships.

The report, PB 121006 "Study of Effects of Alloying Elements on the

Versatile—Dependable

INCO-ROD "A" electrode fills a long-felt need.

It joins many combinations of dissimilar alloys.

Use INCO-ROD "A" electrode to weld mild steel to 304, for example. Or 405 to 304. Or Monel* nickel-copper alloy to 410. Or 347 to Inconel* nickel-chromium alloy.

With each combination, the weld is strong and ductile . . . of X-ray quality. Corrosion resistance and mechanical properties usually equal or exceed those of the base metal. What's more, operability is excellent in any position . . . spray type arc . . . good slag removal.

More than thirty such combinations have been welded successfully with INCO-ROD "A" electrode. Industry is trying many other combinations . . . both between and among ferritic and austenitic stainless steels, low alloy steels, mild steels, high nickel alloys, and other types of alloys.

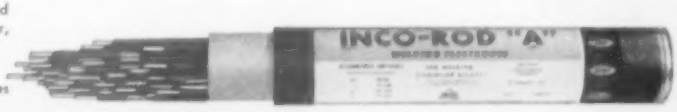
Better than 90% of all such jobs can be handled with this one versatile, new electrode . . . INCO-ROD "A"... the one with the *green* flux coating.

For welding data on *proven* combinations between common alloys, write for 'Announcing INCO-ROD "A"'. . . a new Inco folder. Be sure, too, to ask about alloys *you* commonly join. New data, not yet published, is constantly coming in from the field.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

*Trade Mark of The International Nickel Company, Inc.

Four convenient sizes handily packed. INCO-ROD "A" electrode is supplied in 14-inch lengths in four diameters, 3/32", 1/8", 5/32" and 3/16-inch (the 3/32-inch is center grip) packed in 5-lb., tubular, asphalt-lined, protective containers (NEMA color coded).



INCO **Welding Products** • electrodes, wires, fluxes

Weldability of Titanium Sheet," by H. M. Myer, Armour Research Foundation for Wright Air Development Center, U. S. Air Force, may be obtained from OTS, U. S. Department of Commerce, Washington 25, price $4. It is dated June 1955 and contains 316 pages.

Tubing Data Folder

Engineers associated with the design of equipment involving the use of tubing at elevated temperatures and pressures will be interested in a new technical data folder published by the Tubular Products Division of the Babcock & Wilcox Co. This folder gives the maximum allowable stress values (S) for ferrous pipe and tubing. Included are the values at various temperatures for a complete range of seamless and welded carbon, alloy and stainless tubing steels. Also included in the folder are the formulas to be used in connection with the stress value in calculating the maximum allowable working pressures. Copies of the data card, identified as TDC-154A, can be obtained without charge through the company's general sales offices located at Beaver Falls, Pa.

Welding Data Book

A new 140-page Pocket Data Book (T I S 2575) featuring simplified welding procedures for *every base metal* is now available free from Technical Information Service, Eutectic Welding Alloys Corp., 40-40 172nd St., Flushing 58, N. Y. The book covers 120 welding rods, electrodes and welding compounds.

The pocket-size Data Book is a guide to improved torch and metallic-arc welding, brazing and soldering. Useful "how-to-weld" information is given for fabrication, maintenance repair and salvage, overlaying for wear and corrosion resistance and welding of dirty, rusted parts.

Eutectic's Pocket Data Book is also available from any of the Eutectic District Engineers.

Ultrasonic Systems and Applications

The benefits which may be derived from ultrasonic techniques in cleaning and degreasing, electroplating, soldering, drilling and grinding operations are reported in new Bulletin MW-103 just published by Acoustica Associates Inc., Glenwood Landing, L. I., N. Y.

Entitled, "Ultrasonic Barrier Broken by Low Cost Power Supply," the 4-page, 2-color bulletin also describes various ultrasonic power supplies, transducers and systems for small- and large-scale production requirements.

A free copy may be obtained by writing Acoustica Associates, Inc., Glenwood Landing, L. I., N. Y.

Check Now!

Do you know the advantages you gain through AWS Membership? Why not investigate?
Write AMERICAN WELDING SOCIETY, 33 West 39th Street, New York 18, N. Y.

Flame Machining

The advantages of Cogmatic precision flame machining are explained and illustrated in a new booklet recently published by Seaman-Andwall Corp., Milwaukee, Wis. This is a patented process for producing large sprockets and gears automatically, involving the precise control of a fast-cutting torch guided by special cams and change gears for control of tooth shapes, sizes and spacings. The machine is automatic, accurate to tolerances ranging from ±0.007 in. on smaller sprockets to ±0.015 in. on larger sprockets and gears.

Copies of the new booklet are offered without charge by Seaman-Andwall Corp., Cogmatic Division, 305-A-2 N. 25th St. Milwaukee 1, Wis.

Resistance Welding Machine

Sciaky Bros., Inc., 4915 W. 67th St., Chicago, Ill., introduces Bulletin 335-1 completely describing the Sciaky type SPT 1 spot welder and the EPT 1 projection welder. Both of these machines are air operated, press type, patented three-phase, and designed to cover a wide range of commercial welding applications.

This brochure fully describes the machines and is supplemented with dimensional drawings and illustrations. The tooling required to convert the EPT 1 from projection to spot welding is also shown. Machine data are tabulated to indicate kva range, throat depths, welding capacities, electrode forces, etc.

For more complete information, write direct to the above Chicago address, Department L-8, for your free copy of Bulletin 335-1.

restore worn teeth
TO FULL SIZE FASTER
MANGANAL
T. M. Reg. U. S. Pat. Off.
CAST 11%-14% MANGANESE STEEL
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INDIVIDUAL SLIP-OVERS
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SPECIALIZED WELDING GUNS FROM ONE PROGRESSIVE STANDARDIZED MODEL

PROGRESSIVE'S EXCLUSIVE NYLON GUIDE

- Constant guide and support throughout stroke
- Self-insulating
- Resists weld spatter
- No lubrication required

Both Progressive guns in the above illustration have the same chassis—the difference is in the interchangeable cylinders, jaw extensions, electrode adapters, and tips.

Using Progressive's original Standardized Chassis and interchangeable parts, job-specialized portable welding guns can be made for a fraction of the cost of specially-designed guns.

Progressive has more portable guns in use than all other manufacturers combined. For information on any type of Special or Standard Portable Gun—write to Progressive in care of Department G.

The PROGRESSIVE Welder Sales Company

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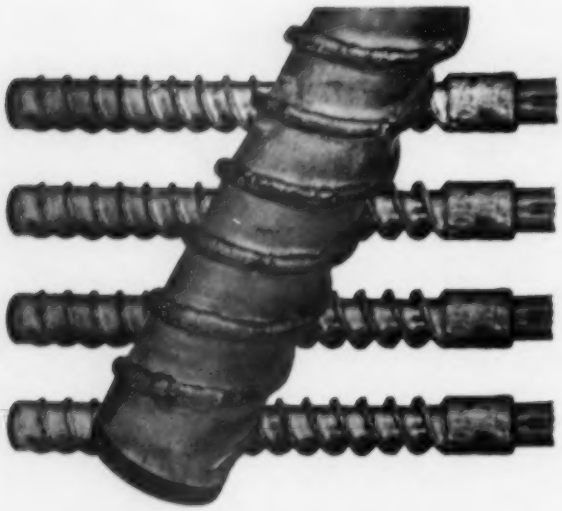
Group of special jaw designs demonstrating wide versatility of Progressive Welding Guns.



Colmonoy INCREASES Extrusion Screw Life

Tests revealed a tremendous increase in the service life of these Colmonoy hard-faced extrusion screws, as against the unprotected screws usually used. Orders for new replacements now specify Colmonoy hard-facing.

Used for extruding plastic, these screws are made of age-hardening nickel-base alloy. This alloy is now readily hard-faced with little loss of hardness, using Colmonoy No. 6 gas rod and a new Colmonoy high temperature flux.

The 60-inch screws have a .050" overlay of Colmonoy No. 6 when finish ground. Colmonoy hard-facing pays for itself in increased life very quickly on expensive parts such as these.

To provide any metal part with longer life, investigate Colmonoy alloys and methods. They represent a complete line of wear resistant alloys and the most up-to-date in hard-facing techniques.

Submit part drawings and a description of the wear encountered for a specific recommendation. Request Hard-Facing Manual No. 79.

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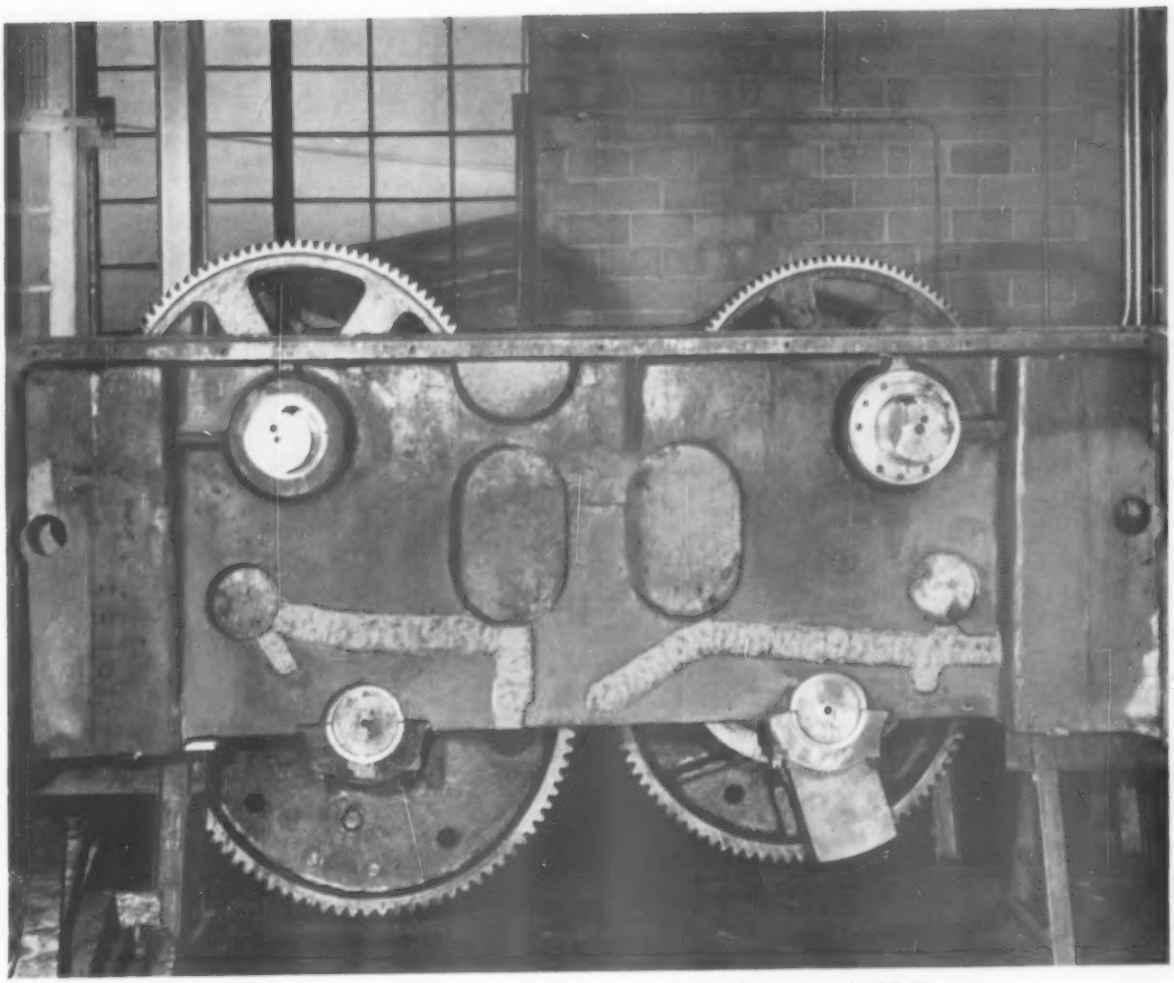

Two of the braze welds made in this big press crown with ANACONDA-997 (Low Fuming) Bronze Rod. All four cast-iron partitions in the crown were repaired.

After other repairs failed, Braze Welding with Anaconda Rod restored this iron press crown

When this 16-ton crown of a double-action press first failed, it was repaired by electric arc-welding using a high-strength nonferrous electrode. This joint failed.

The Punch Press Repair Corporation of Ferndale, Mich., cut out the old welds and braze welded all four of the cast-iron partitions in the crown, using a total of 800 pounds of 3/4" ANACONDA-997 (Low Fuming) Bronze Welding Rod.

Its useful life extended, the press is back in active service at the plant of a large tool and die firm in Detroit.

ANACONDA-997 (Low Fuming) Bronze is a superior welding rod used to join gray and malleable cast iron, steel, and copper alloys by the oxyacetylene process. It is one of a broad line of Anaconda Welding Rods that are finding increasing applications in production and repair welding. Anaconda Welding Rods are sold by distributors of welding equipment everywhere.

See your Anaconda distributor or write: The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

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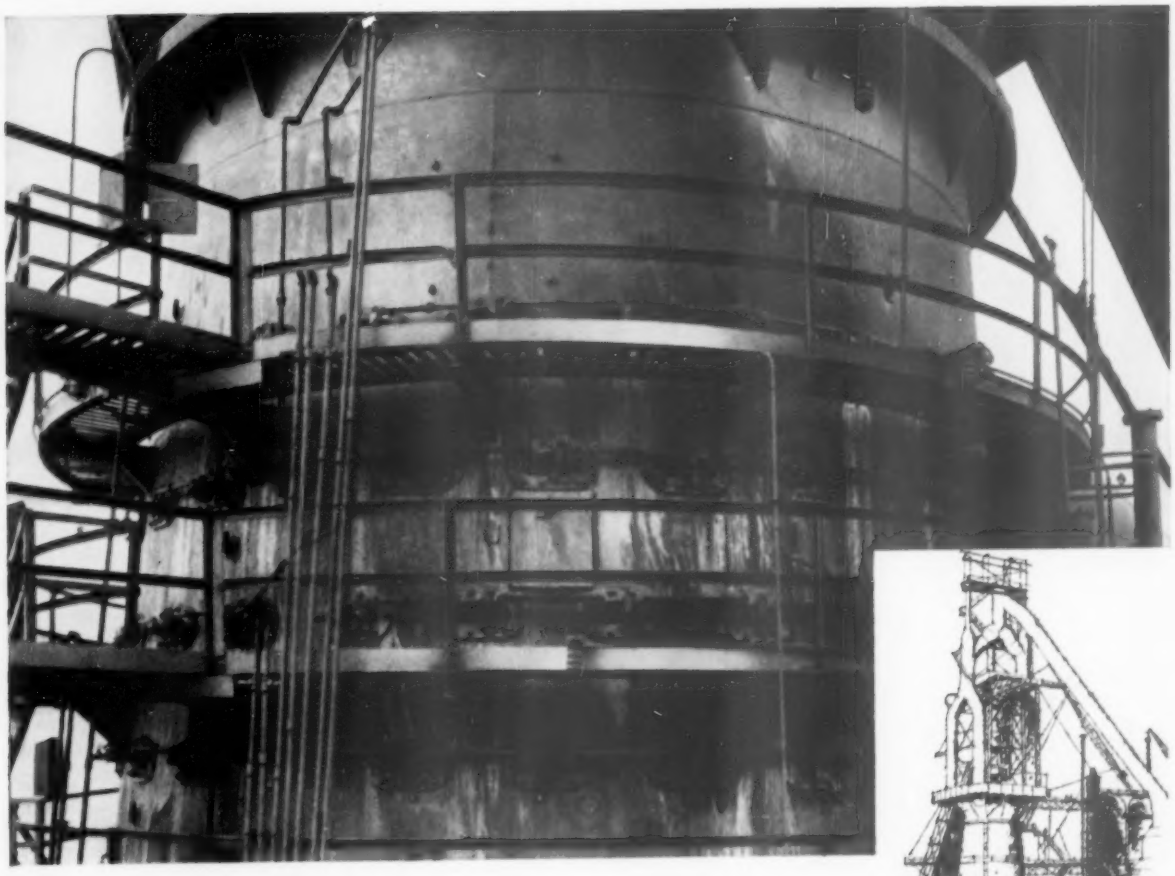
Sold by distributors of welding equipment everywhere



Why Airco 78E electrodes were selected to weld blast furnace "R"

A large eastern steel producer planned to build the giant blast furnace designated "R". Welding – with its obvious advantages of speed and economy – was naturally selected as the best method of construction.

But – which electrode would best do the job? These were the factors involved in making a decision:

(1) Quality of weld deposit. Welds had to be leakproof to contain the 15 lb. psi pressure in the vessel. **(2)** High ductility and tensile strength were of prime consideration. **(3)** An all-position electrode was absolutely essential.

The Airco 78E electrode answered all these qualifications. Therefore, it was the logical choice. A total of 13,500 pounds of Airco 78E electrodes were used to weld the structure.

In building a blast furnace – or rebuilding an engine housing – Airco's Electrode Pocket Guide can help you take the guess work out of selecting the right electrode for the job. This 44-page booklet contains neatly condensed descriptions, applications and procedures – plus charts and graphs – for using the complete Airco line of electrodes.

It's free. Write Airco, at the address below. Request Catalog 1318.

welding
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